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1892

THE

PLANT WORLD

A Magazine of Popular Botany

ORGAN OF THE
WILD FLOWER PRESERVATION SOCIETY OF AMERICA

EDITED BY
FRANCIS ERNEST LLOYD

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The Plant World

A Magazine of Popular Botany

JANUARY, 1905

PHYSIOLOGICAL DROUGHT IN RELATION TO GARDENING.*

BY ISAAC BAYLEY BALFOUR, F.R.S.,

Professor of Botany in the University of Edinburgh; Queen's Botanist in Scotland; Regius Keeper of the Royal Botanic Garden, Edinburgh.

Water-relationship of Plants in Nature.—Everyone who has to do with the cultivation of a varied collection of plants learns by experience that of all the factors of environment more or less under control no one demands more attention than that of water-supply, and it is a critical one in gardening. That this should be, emerges from the phyletic history of the plants we cultivate as descendants of primitive marine forms, and from our dominant plant-forms being those which have solved satisfactorily the problem of adequate water-supply in correlation with a land-life, no less than from the fact that the distribution of vegetation at the present epoch is primarily conditioned by relationships to water —relationships which we now know are not simply physical but physiological, conditioned, that is to say, not by the amount of water present but by the degree in which it can be absorbed by the plant.

Water-relationship in Horticulture.—As in nature so in horticultural practice this physiological relationship to water is fundamental and furnishes the key to many of those paradoxes which puzzle us in our treatment of plants in the garden; and its right appreciation should afford helpful guidance to methods of cultivation.

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* Read before the Botanical Society of America, at Philadelphia, December 29, 1904.

Can Nature Guide Horticulture?—The amount of truth in the statement that horticulture as an empirical art can obtain but little guidance from botany and a knowledge of the conditions under which plants occur in nature, depends upon the degree of our ignorance of the influence of environmental factors and of the relationships of plants to them, and of our grasp of physiological as distinct from physical effects. With increase of knowledge the validity of the statement must decrease. In no direction has research in recent years provided more valuable data of significance to horticulture than in that of the water-relationships of plants—the conception of physiological drought is far-reaching.

Soils and Physiological Drought.—Our knowledge of the mechanical and chemical states of soils, of their varying retentiveness of water, and of the effect upon this of aëration and temperature, tells us that soils, anatomically and constitutionally different, may be physiologically alike in respect of the water-relationships of plants. It sounds paradoxical to say that a soaking peat-soil is to plants in respect of water like a desert-sand, a salt-strand, a tufa, a half-frozen loam, a tree-bark. Yet all are physiologically dry to the plant—a critical item of botanical information to the gardener.

Plant-form as a Guide to Cultivation.—From the side of the plant itself—aquatic adaptation is so distinctive, so different from terrestrial and epiphytic, as to have been always a natural botanical indication of cultural conditions upon which the gardener has acted; and if horticulture can derive guidance from such prominent botanical features, appreciation of the significance of plant-form in terrestrial and epiphytic plants should be no less instructive.

Water-conservation and Water-obtention.—In the attitude of these plants to their water-supply we recognize conservation, mainly exhibited in the shoot, and obtention, chiefly centered in the root, and these are varyingly correlated, predominance of the latter making for success in our epoch—witness the relative subordination of the gymnospermous to the angiospermous type.

Shoot-form and Water-conservation.—Our grouping of plants as hygrophytes, tropophytes, xerophytes, and recognition of chylophylly, chylocauly, ericoid habit and the like, bear witness to our appreciation of the influence of the water-relation upon shoot-form, internal and external, and tell of its adaptation to water-conservation. We know indeed now so much of the meaning of shoot-form in respect of this factor that we can predicate from its aspect whether a plant is the inhabitant in nature of a physiologically dry or physiologically moist station, and obtain thereby a definite index pointing to the nature of the treatment that should be extended to it in cultivation. We have in fact advanced in our interpretation of adaptations of the shoot to water-supply and now appreciate indications finer than those offered (and acted upon by the gardener) in the distinction between aquatic plants on the one hand and terrestrial and epiphytic plants on the other.

Root-form and Water-obtention.—Root-form in relation to obtention of water has received perhaps less attention—except in the case of the epigeous and more visible roots of epiphytes—and as a diagnostic mark of natural physiological habitat is, as a whole, at least with our present knowledge, not of such conspicuous value in affording a guide to horticultural practice as shoot-form. Moreover many of its distinctive features in relation to water being microscopic they can never be used in practice by gardeners as a test of station. Yet a proper understanding of the ecology of soil-roots as well as of air-roots will give the gardener an explanation of phenomena that puzzle him.

Absorbing and Transmitting Mechanism.—Within the limit of general form imposed by their surroundings, roots are variable and adaptive as are shoots and show remarkable correlations of extent of absorbing area with absorbing and transmitting mechanism in relation to soil-environment and shoot-needs. The story of these is a chapter of root-ecology which has not yet found a writer, so far as I know; when written it will bring out no less distinctive adaptations than in the case of the shoot. The paper, the lines of which I now signalize, contains a contribution to that chapter. Here I will only say regarding absorbing-mechanism, that whilst adaptations to absorption by the root-surface and by root-hairs are generally accepted phenomena, insufficient recognition has been given to the part played by fungus-mycelium in symbiotic mycorrhiza. Its adjuvant character in feeding has been long advocated, although there are those who hold that the condition is purely pathological. I conclude, however, from observations on cultivated plants, that the cooperation of fungus-mycelium and root is not a feature of only certain species as is supposed, but is possible to all rooting plants as an efficient method of water-absorption and is operative where conditions serve. It is never absent from spermophytous plants of all kinds growing with their roots confined in tubs when the roots reach and penetrate the wood of the tub beginning to decay. Then the adaptations to first-transmission of absorbed water are variable and no less important, taking the form, in conditions of physiological drought, of modification of the general cortical cells to facilitate passage of water, but more specially of the development of exodermal transfusion-cells, which are not merely a feature of soil-roots in some few saprophytes, but a widely distributed and characteristic xerophilous construction.

Interpretation of Gardeners' Riddles.—From the many riddles that confront the gardener to which the foregoing data offer a key I adduce the following as illustrations:

Marsh-plants Growing in Sand.—Plants which in nature inhabit marshy stations (indicated often in their specific name, *e. g.*, *Ledum palustre, Scirpus palustris*) thrive in dry sandy garden-soil —from the horticultural standpoint (if flower be the aim) may be said to do better there, for if leafage is less, flowering is more profuse than in the natural station. No apparent cultural paradox is more striking than this. Applying the principle of physiological drought the explanation is clear: physically different, the soil-environment in the two situations is physiologically the same —dry to the plants. The botanically-informed gardener could surmise this from the xerophilous character of the plants.

Epiphytic Orchids in Pots.—Similarly, to the gardener's question: what resemblance can there be between a flower-pot filled with crocks and peat, in which orchids naturally epiphytic are grown in gardens, and the trunk of a tree? the answer is obvious: they are both physiologically dry to the plant. Again in this case the botanically-informed gardener could from the xerophily of the plants interpret conditions.

Rhododendron javanicum.—In nature *Rhododendron javanicum* furnishes an interesting parallel—epiphytic in virgin-forest it is terrestrial on solfatara and on alpine highland in Java.

Xerophilous Plants Indifferent to Cause of Drought.—These and many analogous cases tell us that when a plant is once adapted to conditions of physiological drought, that is to say, possesses xerophilous characters, it is not particular about the factors immediately causing the difficulty in water-absorption or the method in which it is brought about.

Temporary Physiological Drought through Cold.—Bright sunshine, or prolonged winds, or their combination, in late spring in Britain, when the soil though wet is still cold, frequently wreck temporarily the hopes of a coming season in the garden. Such disaster is often attributed to night-frosts. The real cause is a temporary condition of physiological drought checking water-supply to the shoots. The botanically-informed gardener would know that this is induced by low temperature of the soil.

Pot-cultivation Tends to Physiological Drought.—Further specific illustration might be multiplied indefinitely, for the whole system of cultivation of plants in pots as it is ordinarily practised in gardens is one tending to the creation of conditions of physiological drought.

Gardener may Benefit from Botanical Knowledge.—A proper conception of what is implied in physiological drought ought therefore to be part of the equipment of every gardener, for it will provide him with rational guidance in the regulation of the watering of his plants and will enable him to understand why a water-supply may vary in its beneficence or its maleficence in varying soil-environment and to plants of different water-relationship. This he can arrive at only through botanical knowledge from which therefore horticulture can obtain help in regard to a fundamental factor in the cultivation of plants.

A SUMMER IN THE TROPICS.

By Mary M. Brackett.

A year ago it became possible for American botanists to study tropical plants under natural conditions, in a laboratory of their own. For this purpose, the New York Botanical Garden leased from the English Colonial Government a site high up in the Blue Mountains of Jamaica. Cinchona, as the place is called, was formerly used by the Department of Public Gardens and Plantations of Jamaica as an agricultural and horticultural experiment station, where particular attention was paid to the raising of the quinine tree of the Andes. Finally, this project was abandoned, and the work carried on here was removed to other places, but the buildings and grounds were left in good condition, and the directors of the New York Botanical Garden were quick to see the advantages of such a spot to students from the north. Of these, the party of which I was a member were the pioneers.

But it was not altogether as strangers in a strange land that we arrived in Kingston on the morning of the eighth of July. Our steamer had no sooner touched the wharf than a colored messenger handed us a letter on the envelope of which was printed, "On His Majesty's Service." It was from the Hon. William Fawcett, Director of the Public Gardens and Plantations of the Island, giving explicit directions regarding our stop in Kingston and our trip to Cinchona. Some hours later, while waiting for luncheon in the garden of our hotel, we had our first lesson in tropical fruits. A bright little "pickney," with an eye to business rather than to botany, invited us to take his picture while he climbed a cocoanut tree. He literally walked up the tree on all fours and threw down some of the fruit. Then down he came himself, tore off with his teeth the hard outer fiber of the cocoanuts, and proceeded to show, with the air of an experienced demonstrator, how we get meat from ripe cocoanuts, and milk from green ones. That afternoon we had tea at the Hope Botanical Garden with Mr. Fawcett, whom we found a most gracious gentleman, and to whom we were afterwards indebted for the loan of books and herbarium specimens. The next morning at seven o'clock a carriage was waiting at the hotel to take us the first nine miles of our journey to Cinchona.

We thought that we were abroad early, but soon discovered that Jamaica is astir long before seven. All along the route we passed negro market women and girls trudging barefoot into town; for it was Saturday, and that is market day in Kingston. Some led donkeys laden with yams, mangoes, pineapples, bananas and other fruits and vegetables; but the majority, after the fashion of their country, carried their produce in large round baskets on their heads. At the little hamlet of Gordon Town we mounted ponies for a thirteen mile ride up the mountain trail. Wilfred, our black guide, led the way on a mule, astride of bags and suit-cases—the larger pieces of baggage had gone on ahead—and another black boy brought up the rear on foot, clinging to the tail of the last pony. It was a glorious morning! All around stretched the

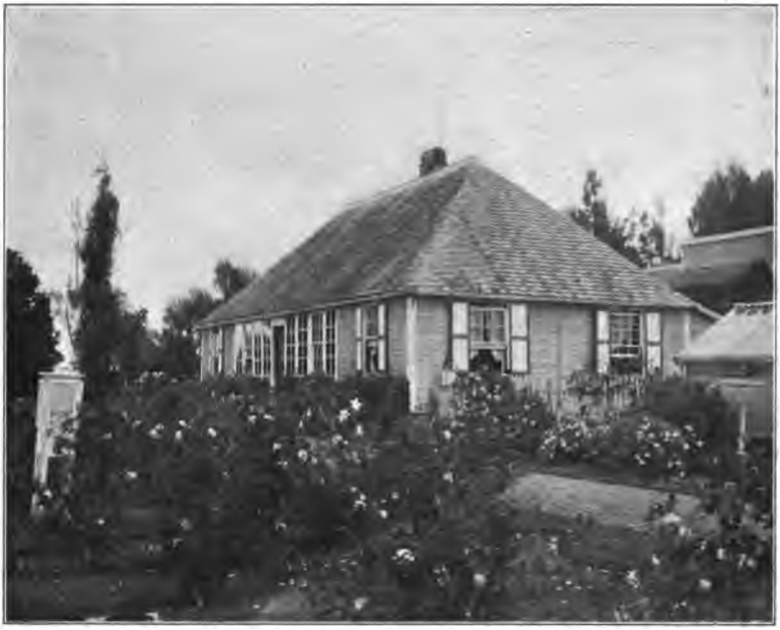

FIG. 1. The Residence of the Director at Cinchona. (Courtesy of New York Botanical Garden.)

Port Royal Mountains, whose steep slopes we were slowly climbing in a zig-zag ascent. Now and again, through their gaps, appeared the blue waters of Kingston Harbor. The vegetation was of ever increasing interest. Cocoanut palms and banana trees were everywhere, as also the mango, and the handsome breadfruit tree. We learned to recognize the alligator pear, the custard apple, the cherimoya and the red fruits of the akee. Among the many unfamiliar flowers, we noted the scarlet hibiscus, and, what we especially admired, the pink blossoms of a wild begonia. At an elevation of 4,000 feet we descended into the valley which separates the Port Royal from the Blue Mountain Range, on a spur of which lies Cinchona, 5,000 feet above sea level. After fording the Yallahs River, a small stream at this season, we began the final ascent. On nearing the summit, we saw two of our own plants, the peppergrass, *Lepidium,* and the wild carrot.

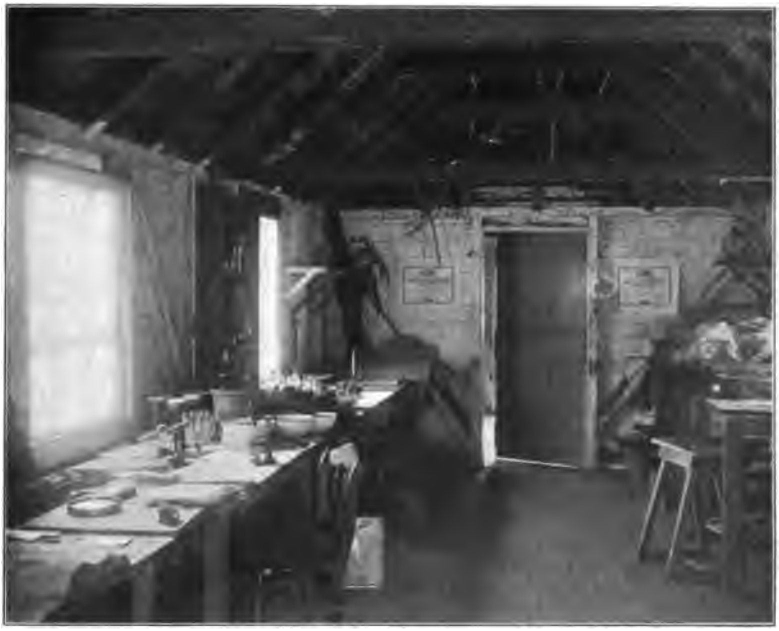

FIG. 2. Interior of the Laboratory. (Courtesy of the New York Botanical Garden.)

The latter part of our journey is chiefly memorable for the drenching we received. When we were about three miles from Cinchona it began to pour, but we could only stick to our ponies and shiveringly recall all we had been told of the fever that threatens foreigners who get wet in the tropics. An hour later our drooping spirits revived under the hospitality of Mrs. Harris, wife of the superintendent of Hope Gardens, who was to care for us during our stay. That evening, as indeed every evening thereafter, we sat around an open fire. On retiring we called for more blankets, and found use for a heavy steamer rug that had been discarded while on the ocean, and we tried to keep warm by reminding ourselves that we were within 18° of the equator!

The dwelling house at Cinchona stands in the midst of a rose garden. From the doorstep, looking south across valley and mountain, we could see the white roofs of houses down in Kingston, and still further, Port Royal, the port of Kingston, and the sea. A terrace in front of the garden slopes down to the nursery, where flourish a number of local and introduced trees and shrubs. Back of the house are the servants' quarters, the stable and the laboratories. Of the latter, there are two buildings. The one we used is a simple, one-story, wooden structure about thirty feet long. On our first inspection, it contained only crude wooden tables running the length of the room, some shelves and a quantity of driers. But after we had arranged our glassware and apparatus on the shelves, and had set up a formidable array of bottles filled with killing fluids, and had brought out our microscopes and other instruments, we had as satisfactory a work room as one could wish. The only convenience lacking at present is running water. Just outside the laboratory is a stone wall where we laid in the sun the driers, of which we never had too many hot ones for our specimens.

From the grounds a walk of three miles takes one through Morse's Gap, where are found all the treasure of a tropical vegetation. Here the mistletoe thrives on trees and bushes in the open places; orchids, "wild pines"* and other epiphytes lodge on the branches; here the tree fern is seen in all its glory; mosses and lycopodiums cover the banks; while most abundant and varied of all are the ferns, the branching *Gleichenia, Hypolepsis* with prickly stem, forming dense thickets where it climbs, the silver lined *Ceropteris,* and a species of *Dryopteris* with fronds eight feet long; and in the denser parts, where the climbing bamboo festoons itself like a curtain from tree to tree, the filmy ferns, *Trichomanes* and *Hymenophyllum,* the smallest and the daintiest of their kind. Beyond Morse's Gap rises John Crow peak, the ascent of which takes one through a primeval tropical forest where the undergrowth is so thick that it is necessary to cut a trail to reach the summit, a height of 6,100 feet.

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* *i. e.*, pineapples.

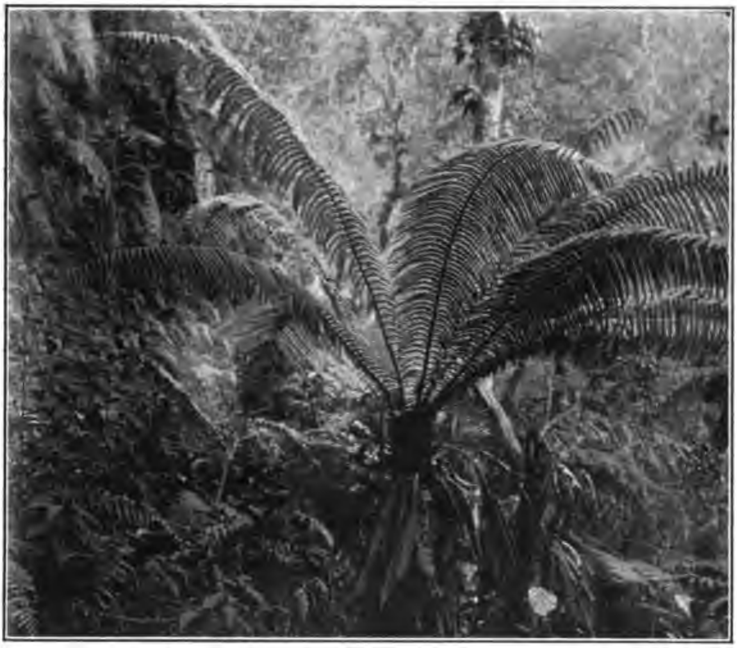

FIG. 3. "A species of *Dryopteris* with fronds eight feet long."

On all our longer tramps our guide and counsellor was David Watt, the colored caretaker of the station. Armed with his "machette," or cutlass, he made passable the forest trail, and his keen eye was quicker than ours to detect a coveted specimen. David has contributed several new species of plants to the Hope

Garden herbarium. There is one mistletoe he can see a mile off —it is *Phoradendron Wattii.*

The popular belief about mistletoe is still, it seems, that it is all of the Christmas variety, and that it grows exclusively on the oak and the apple. In Jamaica there are neither oak nor apple trees, and the twelve species of the Loranthaceæ we brought back show many differences in form and color. Some of the species of *Phoradendron* have the waxy white berries of the European *Viscum album,* while another of the same genus has yellow berries. There is the handsome *Dendropthora* whose berries are scarlet, and a *Dendropemon* with green berries banded with orange. The flowers also vary, from the inconspicuous apetalous blossom of *Phoradendron,* to the long, tubular corolla of *Oryctanthus.* The mistletoe—"God-bush," the negro calls it—does not select any one tree as its host, but grows equally well on the wayside bushes, the brush broom and the bitter broom; on the soap wood, the juniper, the cherimoya, or the lime. Sometimes the parasite grows out from the host like one of its own branches; again, slender stems wind about the host plant, sending out haustoria at intervals which penetrate the outer bark.

On the neighboring hills, some 2,000 feet below Cinchona, are several coffee "properties." This gave us an opportunity to see the coffee on the tree, both in flower and in fruit, as well as on the barbacue. The coffee of these mountains is considered the finest in the world, but nowhere else is it obtained pure, for the entire crop is sent to England, where it is mixed with other brands. One afternoon, as we were returning from a long tramp, we passed through one of these properties. Meeting the son of the owner, we were invited to stop and rest at the house, which we were very glad to do, as we were hot and tired. The young man's mother received us most hospitably, and later, very willingly explained the process of drying, pulping and sorting the coffee berries. The entire work is done by the negroes whose huts are scattered over the plantation. Our hostess said that we were the first white people she had seen in two months. She had lately sent her youngest three children to school in England, and was feeling very lonely in consequence. While we sat in the little parlor, admiring the family photographs, a negro maid-servant in neat calico gown, gorgeous bandana, and bare feet, brought in a steaming tray. We still remember with singular pleasure that cup of Blue Mountain coffee on "Strawberry Hill"!

(*To be concluded.*)

AN UNUSUAL BEGONIA.

In a recent number of the *Bulletin of the Missouri Botanical Garden* Professor Trelease describes a peculiar species of Begonia which he found growing on the sides of a deep cañon in Mexico.

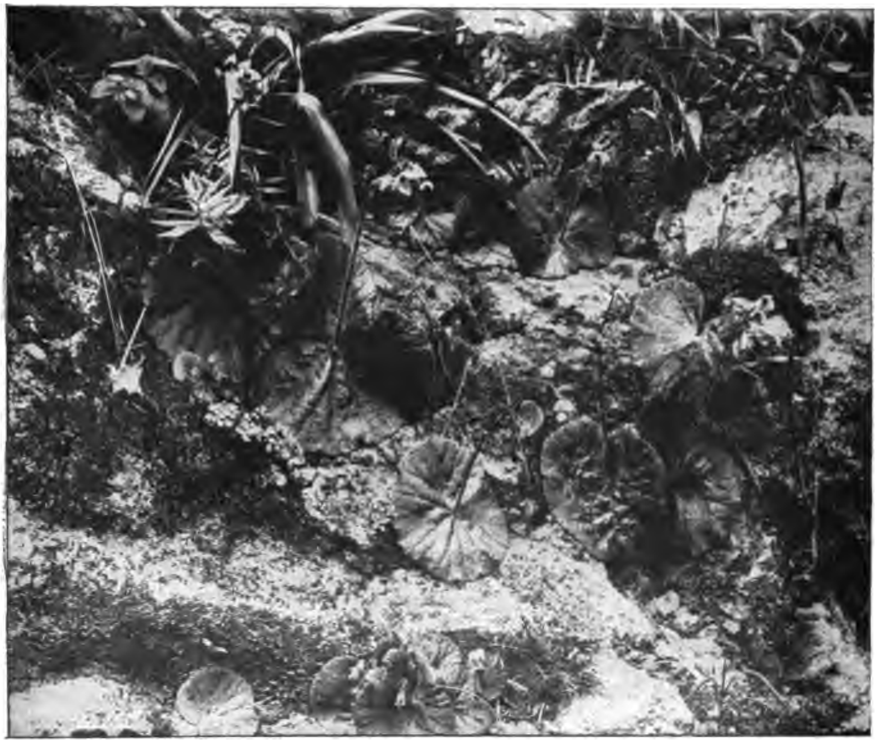

FIG. 4. *Begonia Unifolia.* (Courtesy of Professor Wm. Trelease.)

When identified the plant was found to be *Begonia unifolia* Rose, a species only recently discovered and never before described.

This *Begonia* is of particular interest for two reasons: first, occurring in Mexico, this species grows further north than any of its near relatives, the so-called tuberous begonias, most of which come from the Bolivian and Peruvian Andes and some of which are now popular in cultivation; second, and for this reason especially, the plant has a peculiar habit of growth. *Begonia unifolia* possesses a single, large, flat, orbicular leaf which is sessile on the underground stem and is therefore closely applied to the ground. Through the sinus in the leaf rises the flower stalk bearing both pistillate and staminate flowers which are white in color.

This single leaf lying flat upon the ground recalls a similar habit in several species of *Streptocarpus,* in which one of the two cotyledons enlarges greatly and spreads out as a gigantic foliage leaf, while the plant develops no other leaves. The staghorn fern (*Platycerium*), common in large greenhouses, likewise develops, besides its forked, antler-like fertile fronds, one or two green disk-shaped sterile fronds which resemble immense prothallia and remain always at the base of the plant. Since this fern grows naturally on tree-trunks in tropical forests, these broad basal leaves doubtless aid in retaining moisture for the roots and collect also organic materials.

In the case of this *Begonia* described by Professor Trelease, growing as it does on steep, rocky, cañon walls, possibly this low, broad leaf performs the same functions—providing protection for the subterranean parts and helping to retain the moisture and organic materials which pass its way. ADA WATTERSON.

UNDER THE TITLE "A New Conception Concerning the Origin of Species" Professor Hugo de Vries gives in *Harper's Monthly Magazine* for January, a personal account of the way in which the author was led to make his experiments which led to the formulation of the Mutation Theory of the Origin of Species. In SCIENCE, 20: 395, September 23, 1904, Professor de Vries published another important communication on the "Evidence of Evolution," in which he considered in a broad way the Darwinian concept of descent, and its relation to the Mutation Theory. He there "intimates that the real significance of the newer ideal lies not so much in its substitution for the older, as in its importance in pointing out new lines of research."

THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

The annual meeting was held in Biological Hall of the University of Pennsylvania, in connection with the meeting of the American Association for the Advancement of Science, on December 30, 1904. Mr. Joseph Crawford presided. Reports of officers were read and accepted, and Dr. Waters announced a balance in the treasury. The following officers were declared elected: *President,* Professor Charles E. Bessey; *Vice-President,* Mr. Joseph Crawford; *Secretary,* Mrs. N. L. Britton; *Treasurer,* Dr. C. E. Waters. Professor F. E. Lloyd and Mr. C. L. Pollard were elected to serve for one year on the Board of Managers, and Dr. Wm. Trelease, Mr. Frederick V. Coville, Professor W. A. Kellerman and Professor C. F. Wheeler to serve for three years.

The PLANT WORLD will continue to be the organ of the society, and the dues will be fifty cents without the PLANT WORLD, and $1.25 with it.

The topic for discussion was " The Destructive Effects of Fire." Mrs. Britton opened the discussion by stating that she had received from the Bureau of Forestry of the United States Department of Agriculture copies of their circulars and posters relating to forest fires and the Annual Report from the Department of the Interior for 1904. Posters and maps were exhibited showing the extent of fires in the Adirondacks during the year 1903. The extent of these may be judged when it is stated that between " April 20 and June 8, 1903, over 600,000 acres of timberland in northern New York were burned over. About $175,000 was spent in fighting the fires, which nevertheless were finally extinguished only by the help of heavy rains. The total direct loss was approximately $3,500,000. No less serious, though incapable of money valuation, is the indirect loss due to the destruction of young growth which was to form the future forest. To this must be added the injury to the forest soil caused by the burning out of the vegetable matter indispensable to healthy tree growth."

Dr. H. C. Cowles, of Chicago University, stated that the devastation caused by forest fires in the Rocky and Cascade Mountains is appalling, especially in Idaho, Montana and Washington, where the coniferous trees spread the flames over miles of territory and destroy all other vegetation as well. He stated that fires had swept over thousands of acres in the San Francisco Mountains of Arizona, and that it was almost impossible to check it, owing to the sparse population. It has been shown by Professor Bessey that with the settling of the Prairie States, devastating fires have become less frequent, as settlers protect their homes. The only means of prevention seems to be a healthy public sentiment. In the vicinity of Chicago, an effort is being made to set aside "university reserves," in order to preserve the most interesting ecological features such as typical swamps, beech woods, etc., including all the plants of these natural formations.

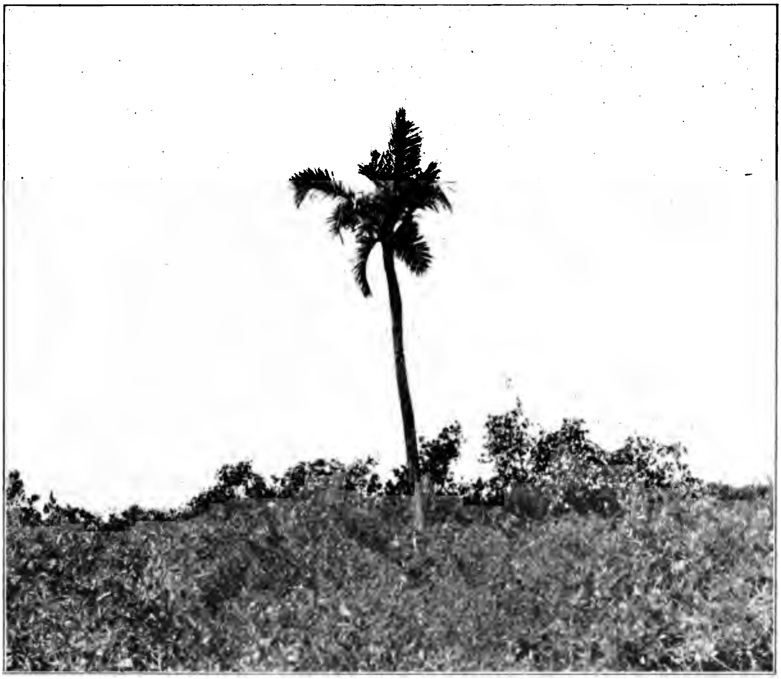

FIG. 5. The solitary remaining individual of Sargent's Palm, on Elliot's Key, Florida. (Courtesy of the New York Botanical Garden.)

Professor P. H. Rolfs, of the Subtropical Laboratory at Miami, Florida, spoke of the opening up of the Homestead lands by fire and axe, and how rapidly some of the most interesting features were being destroyed. He particularly regretted the destruction of one of three of the sites where the royal palm is native in Florida, and stated that it was evident that restrictive measures limiting the time of year at which fires might be set were necessary. He also stated that of all the colonies of Sargent's palm not one remained and as far as he knew, and but one solitary individual was still growing wild, in its native habitat. He advocated that an effort be made to save the royal palm from a similar fate.

Mrs. Britton called attention to the Canadian laws respecting the administration of public lands, woods and forests, and the limitations as to distance and time of year at which fires may be made. She stated that she had received information that in the pine barrens of New Jersey, near Lakewood and Lakehurst, two health resorts where property is rapidly increasing in value, large and destructive fires had occurred last spring, due entirely to carelessness when they were started.

Mr. Stewardson Brown stated that in the mountains of Pennsylvania where until quite recently beautiful forests of hemlock grew, the lumbermen had penetrated, and following them fire, so that now nothing but weeds and devastation may be seen. In several cases the lumbermen were so careless that not only was the litter which they leave after them consumed, but also much of the timber which they had already cut, and yet no effort was made to prosecute or investigate the cause of the loss. He also stated that in Clinton County, Pa., a large tamarack swamp had recently been burned over, simply through carelessness.

The question as to whether legal advice and information could not be secured, was answered in the affirmative, and it was decided to consult with Dr. J. T. Rothrock and see what measures for the prevention of fires could be enforced. At the suggestion of Dr. Ball, of the Department of Agriculture, a committee was appointed to draft a set of resolutions to be presented to the Forestry Congress at their session in Washington, July 2–5; this committee to consist of Dr. Waters, Mr. Crawford and Dr. Ball.

Mrs. James advocated seeking the cooperation of the various women's clubs, village improvement societies and civic federations.

Professor Hitchcock spoke of the damage to the sand dunes at Cape Henlopen, by the destruction of the trees, and stated that it will result in the changing of the topography of the cape.

It was moved that the managers of the society take measures to bring the matter of educating children and teachers to a better understanding of the dangers from fire, before the boards of education in various cities and states.

ELIZABETH G. BRITTON,
Secretary.

A CURIOUS WHITE OAK.

Last autumn while walking through the woods in the vicinity of Central Heights, East Washington, I came across a curiously shaped tree. The tree had light green, pinnately lobed leaves. oblong acorns about an inch long set in a shallow, rough cup, and light gray bark scaling off in thin plates. It proved to be *Quercus alba* L., the common white oak, which is perhaps the most abundant tree in the forests about the District of Columbia.

For the first four and a half feet the trunk grows naturally in a vertical direction, then it bends abruptly at a right angle for about the same distance, after which it again takes a vertical direction, growing to a height of about thirty feet and overtopping its neighbors.

It seems evident that this tree when fairly well grown into a sapling was broken, perhaps by some boy climbing for a bird's nest. The principal growth then began in one of its limbs, the wound healing and the other limbs and branches gradually dying and dropping off.

It is not unusual to come across queerly twisted branches, knotted grape-vines and oddly shaped roots, but it is very seldom that one sees so large a tree as this was, twisted so very abruptly, especially of a species whose characteristic habit is to grow tall and straight.

Verily, " As the twig is bent the tree is inclined."

C. M. MANSFIELD.

EDITORIAL.

With the present issue the PLANT WORLD enters upon its eighth volume. During the seven years past, it has gradually but surely won for itself a place in botanical journalism, until now its name is familiar to all American botanists and to many lay workers, if we may be allowed a distinction which does not always carry with it a difference. This same issue, too, is the first under its new editorship, and accordingly it offers a fitting opportunity for the editor to indicate the principles which are to determine the character of the magazine.

We have long entertained the belief that science is the property alike of non-professional and professional scientists. The form in which the results of scientific study are first made known is however such that only the specialist can appropriate them. For various reasons few of the rest of us can, by hook or by crook, make these results our own. If this be true, we may, we believe, accept as a corollary to the above statement, that it becomes the duty of those who know to let those who do not know into the secret. To do this is eminently worth while. We conceive that the readers of the PLANT WORLD want to know what those who cultivate that part of science known as botany are doing, and that they desire to be informed as to the development of botanical knowledge. It shall be the business of this magazine to represent the science of botany in this way.

There are very many botanical periodicals, various in size, kind and language. We recall that, a few years ago, when seeking for a digest of an article published in Japan, we finally found the title in a well-known compendium, but with no abstract. Instead were the words, *"In Japanisch geschrieben."** This sententious summary of the situation describes equally well, *mutatis mutandis,* the condition for almost every one interested in botany who by fortune is removed from a large center. The literature, regarded simply as a mechanism, is inaccessible. If a single magazine is subscribed for, or two or three, only a very trifling fraction of the whole result is available. Add to this the technical character of the matter and the language used as a medium, and at once, in the majority of cases, the availability is reduced beyond all reasonable limits of profit on the investment. We believe that in this regard the PLANT WORLD may fill a rôle of usefulness by bringing to the attention of its clientele the new work of botanists, thus making it possible for any one who desires to do so to follow the main trend of advance in botanical knowledge.

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* "Written in Japanese."

There is much literature of value and interest to all botanists which avowedly does not embody original investigation. Accounts of travel, observations of various kinds on the structure and habits of plants, and the experiences of earnest teachers are of this nature. Such material, so far as it has real merit, we will be glad to publish in the PLANT WORLD.

The PLANT WORLD cannot hope to attain success merely as a means of entertainment, however justifiable this aim may be. There are several magazines which occupy this field with commercial success, and with them we can not hope to compete. Our success must rest upon the usefulness, in a broad sense, of the material published.

We heartily endorse the work of the Wild Flower Preservation Society of America, and we shall hope to be able to bring to the members of this Society the information and material which is of special interest to them. The minutes of the Philadelphia meeting indicate very clearly the great work that it is in the power of this Society to do. We are able through the courtesy of the New York Botanical Garden, to reproduce a photograph of the sole surviving plant of Sargent's Palm in Florida.

The Teachers Department will be continued as heretofore with the purpose of publishing matter of interest and use especially to teachers of botany. The pages will contain short articles of educational import, and digests of the literature pertinent to the needs of teachers and students. Contributions from teachers in Universities, Colleges and High Schools are earnestly requested. This department will be under the charge of Professor C. Stuart Gager, of the State Normal College, Albany, N. Y.

THE TEACHERS DEPARTMENT.

Biology and Physical Science as Taught in Russian Secondary Schools.

The course in biology in Russian schools extends through three years. Botany is taught in the first year, zoölogy in the second and physiology in the third. Considering the length of time given, one might expect that the pupils would get a pretty good knowledge of every one of these subjects, but, unfortunately, they finish their three years' course, not only with little knowledge of biology, but what is still worse, they have a false conception of the subject. The evil lies in the primitive, unnatural way of teaching. In order to understand clearly the method used, let us imagine that we are listening to a Russian instructor in botany. The announcement made to the class will be somewhat as follows: " For next time the class will prepare seven to ten pages about the plant cell. The plant cell being studied under the microscope is found to be composed of protoplasm, nucleus, chloroplasts and other substances such as starch or fats. The cells of different plants vary in shape. Reproduction is by cell division and by many other ways which are described in your text-book. Do not fail to prepare yourselves to recite all that is written in the text-book smoothly and clearly." In order to obtain the coveted good mark, the pupil recites about the cell with perfect facility, although he does not understand half of what he is talking about. As the instructor shows neither living plant nor illustrations botany offers no interest to the pupil. It seems to have no relation to his everyday life, because when he sees the plants themselves he does not recognize them. None of the knowledge obtained by so many hours of hard study seems to have any connection with the plant kingdom.

From my own experience, I can say that, although I studied botany for two years, I had no real knowledge of plants, until I came to this country, where I studied for the first time a plant cell under the microscope. I could hardly believe that I had seen with my own eyes protoplasm—a substance which had been for such a long time only a name—an empty sound to me. The "laboratory" had been a place where professors only have the privilege to work. After taking up some work in the laboratories in America, I wrote to my friends about it, but it was hard for them to believe, or rather, understand it.

Physics and chemistry are also taught in a ridiculous fashion in Russia. There are neither physical nor chemical laboratories used for elementary teaching. Everything is studied by means of the teacher's instructions and by the text-book. Once in two or three months the tutor performs some experiments in physics, but no chemical experiments are ever shown before the class. It will surprise the reader to know that our school had a pretty good physical laboratory equipped with many and various instruments, but it was forbidden ground. Passing by, we could see the layers of dust which covered the instruments, and I wonder now what the laboratory was for! That no experiments were performed was due, not to the lack of a laboratory, but to the ignorance of the teacher who did not know how to use the capital that he possessed. As for chemistry, we did not even know of the existence of a chemical laboratory. Chemistry was in our eyes a science of nomenclature, of elements, and of formulas which we were obliged to learn by heart, without the slightest understanding of whys and wherefores.

While at home this last summer I visited my old schools and explained to the schoolmasters the teaching methods used in American schools and I described to them the laboratories which I had seen there. In some Russian schools laboratories have been established in the last two years, so that there are hopes that the old and faulty methods will be replaced by a new and useful one. Before I left for the United States I met my old tutor in physics and we had a long talk about the necessity of laboratory work for the student, but it was difficult to convince him. Having no power to struggle against the truth, he pointed out that Russians ought not to take lessons from Americans who recognized no theory at all, but made a god of practice. I could not help laughing at the attitude which he had taken to justify himself. Bidding him "good-bye," I asked him to visit some American colleges in order to see whether attention is paid only to practice, or whether theory also occupies its necessary place in instruction.

FANNIE KAGAN.

AN ANOMALOUS STRUCTURE ON THE LEAF OF A BEAN SEEDLING.*

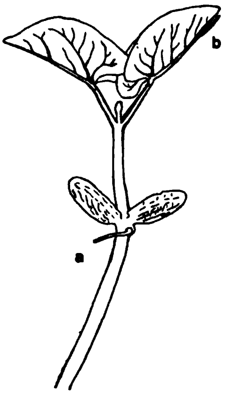

FIG. 6. Bean Seedling with anomalous structures at *a* and *b*. (After Horne.)

Some red Valentine beans were germinated in soil under a bell jar with high temperature and relatively high humidity. After a week's germination, one seedling showed two unusual outgrowths; one just below the cotyledons, the other upon the lower surface of one of the plumules, closely appressed to the midrib. Both structures appeared to be strong root tips, were without chlorophyll and bent away from the light. The lower structure possessed a blunter tip than the upper, and had bent downward. No further development showing, it was sectioned for microscopic examination, and the structure characteristic of a true root were found. A week later the entire plant was becoming unhealthy. The abnormal plumule was examined microscopically.

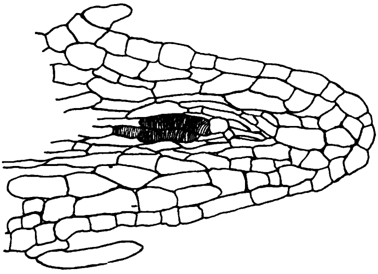

FIG. 7. Longitudinal section of structure shown at *b*, Fig. 6. (After Horne.)

Cross-sections at different intervals from its base showed the outgrowth starting as an enlargement of the parenchyma surrounding the midrib fibro-vascular elements. It possessed almost throughout its entire length an axial strand of vascular tissue. An epidermis with short hairs extended from leaf to tip. No root-cap was observed. It therefore was best considered as an anomalous appendicular structure, stimulated as the lower outgrowth, by abnormal conditions of germination.

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* Horne, W. T., Bull. T. B. C. 31: 585. Nov. 1904.

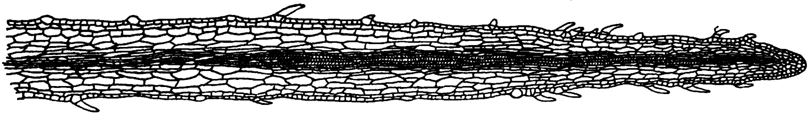

FIG. 8. Tip of section shown in Fig. 7, enlarged. (After Horne.)

M. C. C.

REVIEWS.

Advanced Geography. By RICHARD ELWOOD DODGE. Chicago: Rand McNally & Co. Pp. 333 + xix. Illustrated. $1.20.

It is not infrequent that one whose school days are long past is heard to say " If only I had had the kind of teaching and books and opportunities that the boys and girls of to-day have! " The question of the wisdom of such a remark aside, this is just what the reviewer thought when he glanced over the pages, rich in well chosen and beautifully executed maps and illustrations, of this text-book of geography. It is not extravagant to say that it marks a climax of bookmaking in its particular field. The chief purpose of this notice is to point out the value of the book to teachers of elementary science. A great many of the illustrations would be distinctly useful, for example, in elementary classes in botany, and so the book may well be on the reference shelf of the laboratory.

F. E. L.

NOTES.

THE INFERENCE made in the leading paper of the issue by Professor Balfour in regard to the physiologically dry character of the soil in flower-pots leads me to make the further suggestion, which I do not recall to have seen mentioned but which doubtless has occurred to many, namely, that the constant addition of tap-water to potted plants and its constant evaporation from the exposed surfaces leads to an accumulation of salts in the soil which may be sufficient to increase materially the concentration of solution in the soil water, and this would contribute to the physiological dryness. This point is of particular application to plants grown indoors, where evaporation is very marked, and where the pots are not flushed, in which case the efflorescence becomes pronounced after a time, as all know who have grown plants in the house. Sorauer speaks of the point, but in relation to over-manuring, and recommends the use of pure water* but apparently does not lay stress on the constant addition of ordinary water as a cause. F. E. L.

THE 53RD MEETING of the American Association for the Advancement of Science, held at Philadelphia, December 27–31, 1904, was a notable one from the point of view of botanical science. There met at that time, in addition to the Botanical Section of the Association, the following societies: the Botanical Society of America, the Society for Plant Morphology and Physiology, the American Mycological Society, the Botanical Club of the Association, the Wild Flower Preservation Society of America, the Fern Chapter and the Sullivant Moss Chapter, the Society for the Promotion of Agricultural Science and the Society for Horticultural Science. There were presented before the first three named societies alone, in addition to the annual addresses by the presidents or chairmen, fully seventy-five papers upon the most various subjects. In addition to the scientific interest of the meeting, it derived importance also from the fact that steps were taken by the different leading societies to form a single united society, and it is expected that the common principles agreed upon and accepted by all concerned will form the basis for a complete union of interests.

The next annual meeting of the American Association for the Advancement of Science is to be held at New Orleans, December 28, 1905 to January 3, 1906.

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* Sorauer-Weiss, *Physiology of Plants.*

Volume 8 Number 2

The Plant World

A Magazine of Popular Botany

FEBRUARY, 1905

A GLIMPSE AT EARLY BOTANICAL LITERATURE.*

BY LUCIEN M. UNDERWOOD,

Torrey Professor of Botany in Columbia University.

The average botanical student who has not seriously studied the history of his subject often becomes imbued with the idea that his science dates back only to Linnaeus whom some of our earlier text-books even have called the " father of botany." Those who do not hold this erroneous impression are likely to hold one equally incorrect, namely that Linnaeus was the originator of the binomial system of nomenclature. The task of describing plants was very early undertaken and the publication of herbals, as the early floras were called, gave us the body of the very early botanical literature. Some of the earliest published were those of Brunfels (1530–1532), Fuchs (1542), Lobel (1581), Hieronymus Bock (1587), Gerard (1597), and Dodoens (1644). These herbals written in Latin as the current language of learning, but often in the quaint old German, Dutch or English of their day, described the plants known to their authors giving special attention to their supposed medicinal qualities; and there was scarcely a plant in those days without some reputed remedial properties. Many of these herbals were extensively illustrated, and considering the time in which they appeared these were often very creditable illustrations and are mostly recognizable by those familiar with the common Euro-

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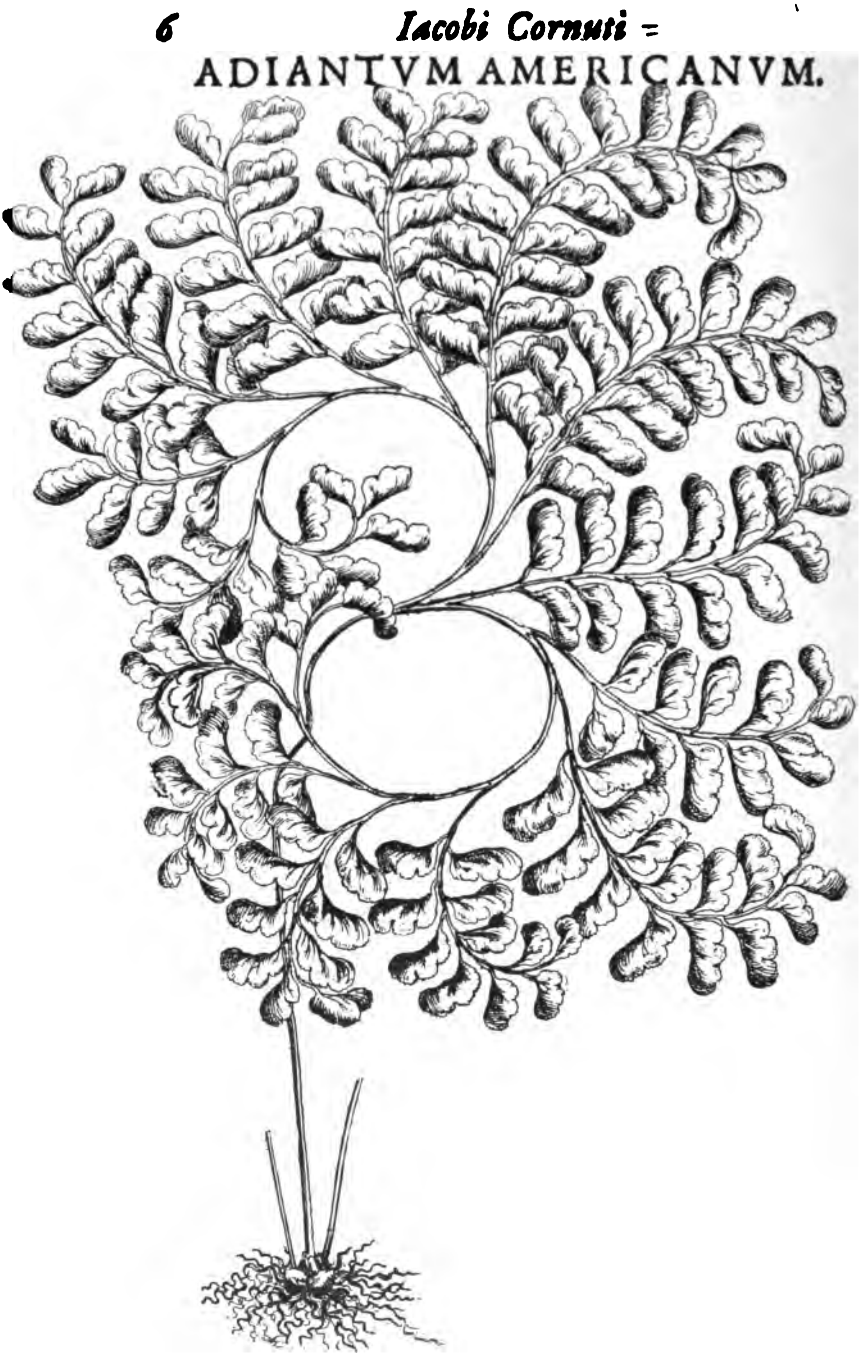
* This is the first of a series of articles, to be published from time to time, on botanical matters of historic interest.



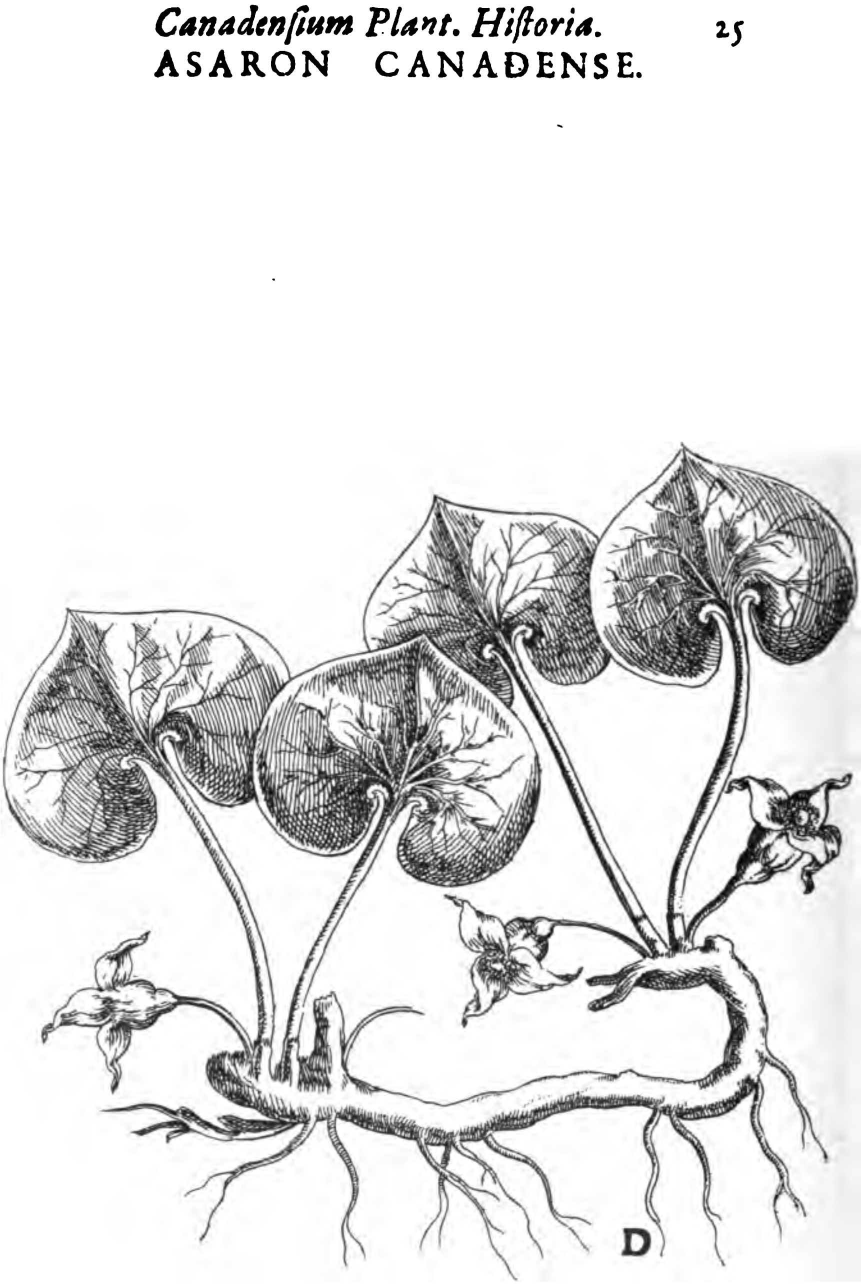
6 ***Iacobi Cornuti*** =

ADIANTVM AMERICANVM.

FIG. 9.—Facsimile reproduction of page 6 of Cornut's *Canadensium plantarum.*

pean flora. Later, as explorations came to be made in distant parts of the world, voluminous floras of tropical regions appeared like those of Rheede for the East Indies (1686), in twelve folio volumes, Sir Hans Sloane for Jamaica (1707), and Plumier for Martinique and Hispaniola (1703). Many living exotics were also introduced into European gardens and elaborate publications were issued describing and illustrating large numbers of these plants. Linnaeus himself published the *Hortus Cliffortianus* in 1737, a folio describing the plants growing in the gardens of George Clifford at Hartecamp in Holland, and among similar works were the *Hortus Elthamensis* (1732) by Dillenius, Commelinus' *Horti medici, Amstelodamensis Plantarum* (1697), and the *Hortus Monspeliensis* (1697), the first describing plants from the Eltham gardens in Kent, the second those from the gardens at Amsterdam, and the third those cultivated at Montpelier in France. Works of these three classes with many others form the enormous volume of early botanical literature from which Linnaeus in 1753 compiled his *Species Plantarum* which reduced the description and classification of known plants to the compass of 1,200 rather small octavo pages. To accomplish the easy designation of individual species he borrowed the plan more or less current among his predecessors of giving each species a binary name—Latin, of course, as the work was printed in that language. As this was the first simple and general enumeration of plants with the present day binomial nomenclature uniformly and consistently used, it has been decided to make the date of publication of the first edition of *Species Plantarum*—1753—the initial point of modern nomenclature.

It must here be emphasized that Linnaeus did not invent this system of naming plants, and that he merely borrowed it and made its use uniform. Caspar Bauhin had used binomials extensively nearly fifty years before Linnaeus was born, and others used them quite frequently. Neither must it be supposed that Linnaeus founded the categories of classification, for genera date back to Tournefort's *Institutiones,* the classic of early systematic botany, published in 1700, and this is supplemented for the cryptogams by Micheli's work published in 1728.



Canadenſium Plant. Hiſtoria. 25

ASARON CANADENSE.

FIG. 10.—Facsimile reproduction of page 25 of Cornut's *Canadensium plantarum.*

In this mass of pre-Linnaean literature there are two books of special interest to the general American student of botany. Parkinson's *Herbal* (1640) is, perhaps, the most noteworthy in the English language and in its 1,688 folio pages one will find a vast fund of information concerning the early popular names of plants, their supposed medicinal properties and quaint methods of use, together with many of the legends and bits of folk-lore connected with common plants. The work is quite copiously illustrated.

The other work is historically more interesting, as it was the first work published in which we find illustrations of our common American plants. It was published in 1635 and is thus only fifteen years later than the landing of the Pilgrims at Plymouth and is a small octavo. It bears the title in Latin: JAC. CORNUTI || *Doctoris Medici* || *Parisiensis* || *Canadensium plantarum* || *aliarumque nondum editarum* || *Historia.*

We reproduce two of the plates published by Cornut in order to give a better idea of this early work. It will be noted that both bear binomial names, although published about a hundred years before Linnaeus had entered the field of publication. It will be further noted that one of them bears the identical name it bears to-day, *Asaron* being only the Greek form of our present *Asarum.*

Finally it may be said that the botanical libraries at St. Louis, Cambridge and New York all contain numerous examples of the various herbals where those interested may consult them at pleasure.

A SUMMER IN THE TROPICS.

BY MARY M. BRACKETT.

(*Conclusion.*)

One morning, about eight o'clock, we passed Solomon, the stable boy, going down the road with an empty wheelbarrow. He said that Mrs. Harris had sent him to market to buy mangoes. We had heard of the Cinchona market held once a week at a near-by cross-roads, and we decided to join the procession of black folk moving toward St. Helen's Gap. The babel of many voices told us when we were drawing near, and at a turn in the road we came upon a novel scene. Black women, old and young, their heads adorned with gay bandanas, were gathered in groups, selling, bartering, gossiping, or wrangling. Here and there stood a patient donkey, relieved for a while of his load which his mistress was probably bartering after the fashion of a game of "Pit," bidding for her neighbor's mangoes in exchange for her own yams, or for scallions in exchange for "pines." These she would sell later in the Kingston market.

The West Indian yam, uncooked, bears a close resemblance to a log of wood. When ready for the table, it is not unlike an Irish potato, only that it is more compact. It is bread and meat to the West Indian negro. One of the chief foods is the chochoe, a small vegetable in taste resembling the squash. The akee, as it hangs on the tree, is a scarlet fruit; it is, however, used as a vegetable. The fleshy yellow interior, fried in lard, and served with salt fish, is a favorite dish "on the plains." The mango, the most common of all the fruits, to be appreciated, must be eaten where it grows. Its fibrous texture and large pit make it a diffi-

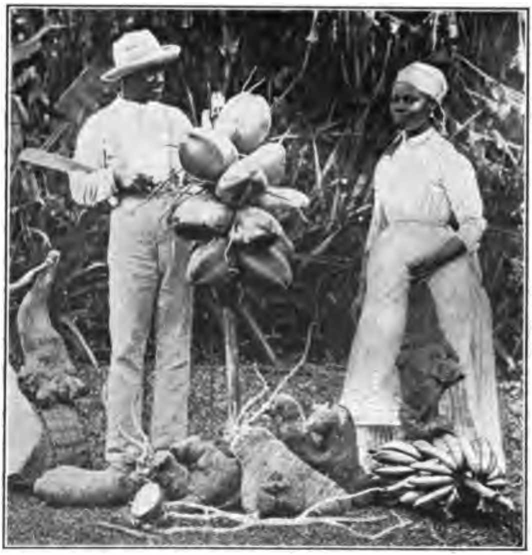


FIG. 11.—Native Jamaicans, with cocoanuts, yams and plantains.

cult fruit to eat, but it is, nevertheless, consumed in large quantities by man and beast. After several trials, we learned to like the sapadillo or naseberry, a fruit that has been variously described as sweetened brown paper, and an over-ripe pear.

A month passed, and we returned to the plains that we might spend a week in sight-seeing on the island. This included a drive to Castleton Gardens, one of the most beautiful botanical gardens in the world, where we stood beneath a banyan tree, and drank from the traveler's palm. As we steamed out of the lovely harbor on the eighteenth of August, we felt that our summer had been well spent; we had seen with our own eyes the wonderful vegetation of the tropics, and had learned not a little of life in a foreign land. And not the least of the pleasant recollections of our visit to Jamaica was of the cordiality of its people.

NOTES ON SOME PLANTS OF NORTHEASTERN IOWA.

By Professor L. H. Pammel.

Iowa is remarkable for its uniform topography over much of the state. The several different ice invasions have left their impress on the flora of the state. This is true in a remarkable degree of the plants found in the Wisconsin drift with its marshes and kettle holes. There is, however, a section in northeastern Iowa which was not affected by the drift. The surface of Allamakee County consists of gorges and ravines, rounded hills and ridges, once largely covered with timber or else open high prairies. Very little of the original prairie remains, as this is one of the oldest settled portions of Iowa. The deciduous trees are such as are common farther north and east. The *Populus grandidentata* is common on the low slopes of the hills, frequently forming trunks sixty feet high, while on the upper slopes of the ridge the *P. tremuloides,* the *P. Pennsylvanica* and the *P. Virginiana* form thickets everywhere on the ridges and slopes. The *Juniperus Virginiana* is common on the limestone rocks. The following oaks are common: *Quercus macrocarpa, Q. rubra, Q. alba* and *Q.*

coccinea. The *Prunus serotina* and *Acer nigrum* are common on the slopes of the hills. There are a few scattered groves of *Pinus strobus* along the Yellow and Upper Iowa rivers. They are found on the limestone and sandstone ledges. We were particularly interested in the plants found along the Yellow River near its source. Through the kindness of Hon. Ellison Orr, of Postville, I made a hasty study of one of the most remarkable spots in Iowa or in any of the neighboring states. Some of the plants found here occur in abundance in some parts of Wisconsin and Minnesota, but they are rare for this section of the country. It is therefore worth while to record a few of the plants found here.

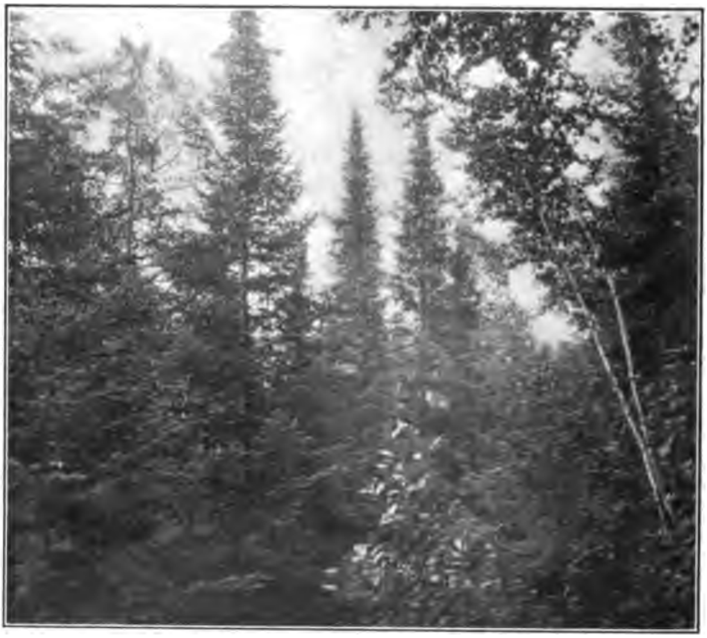


FIG. 12.—A group of Balsam Firs, with one White Pine to the left, and several small White Birches in the foreground. Undergrowth consists of *Aconitum uncinatum, Viola blanda, Diervilla trifida, Pyrus arbutifolia, Cornus circinata* and *Corylus rostrata.* Photo by L. H. Pammel.

The balsam fir (*Abies balsamea*) is common of course in northern Wisconsin and Minnesota. It does not occur in the vicinity of La Crosse or in southeastern Minnesota. *Tsuga Canadensis* occurs in Wisconsin. Balsam fir occurs on the north slope of the Yellow River for about one-half mile. None of the trees are very large; the largest are perhaps 60 feet tall. There are, however, many ranging from a few inches to 20 and 30 feet. When we visited the place, some of the trees were so heavily loaded with fruit that the trees were bent over. It is strange

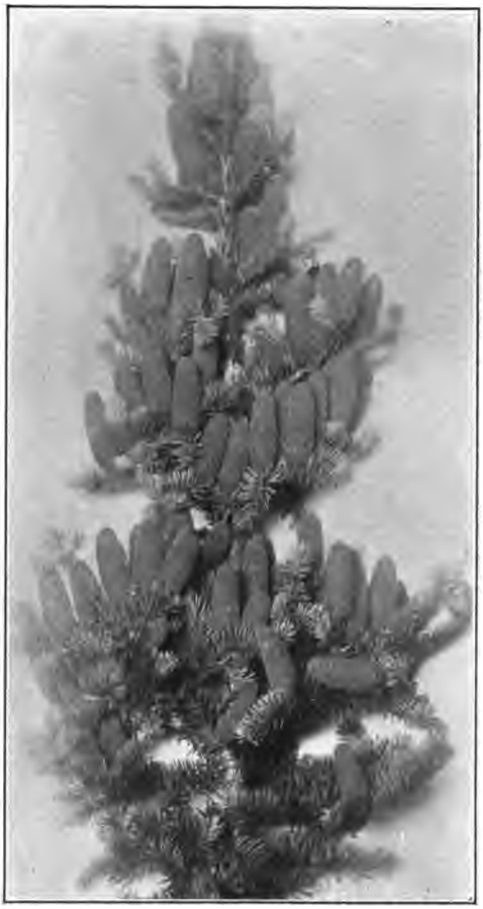


FIG. 13.—Native Iowa Balsam Fir heavily loaded with cones, on the banks of the Yellow River, near Postville, Northeastern Iowa. Photo by Charlotte M. King.

that the species has not spread to the adjoining portions of Iowa. Isolated specimens may have occurred further west and east, but this is the only native grove found in the county. Mr. Holway found an isolated tree near Decorah, and this is the only record I have outside of the Myron* locality in Iowa.

All over Allamakee and parts of Winneshiek and Clayton counties extensive plantings have been made. In most cases these trees came from Myron. Thousands of seedlings have been set out from the Myron grove. In their early stages of growth the balsam fir is a beautiful tree, but at the age of 30 or 40 years the trees die. Some of the largest of the early trees set out are 60 and 70 feet high and 18 inches in diameter. Associated with the balsam fir on the Yellow River is the white pine, which was also loaded with cones, the branches drooping with their great load. The *Viola blanda* and *Campanula rotundifolia* were abundant, the latter and *Arabis lyrata* found on the limestone rocks. The *Saxifraga Pennsylvanica,* usually found in swamps, was abundant in a moist place surrounded with *Hypericum* and mosses. We were especially pleased to find the *Aconitum uncinatum* L. which is recorded for Wisconsin and Minnesota. It was quite abundant in the open places in the woods. *Aralia nudicaulis, A. quinquefolia* and *Hydrastis Canadensis* are abundant in places. *Viburnum Opulus* of our northern swamps is associated with *Corylus rostrata* and *Pyrus arbutifolia.* The *Poa Wolfii* also occurs here.

One would expect to find here three additional conifers: The hemlock (*Tsuga Canadensis*) which occurs in Monroe County on one of the tributaries of the Wisconsin, the Kickapoo; the larch (*Larix Americana*) which is found in La Crosse County, Wisconsin, and near La Crescent, Houston County, Minnesota, and the arbor vitae, which occurs on the sandy rocks in the Dalles of the Wisconsin, but they are absent. The red maple (*Acer rubrum*) might also be expected, but this seems to have reached its western distribution, seven miles from La Crosse on the La Crosse River, although it is abundant in the Kickapoo River valley. The Myron locality is one of the most remarkable spots in Iowa where boreal plants have been preserved. In northeastern Clayton County, not far from Allamakee County, in a bog of considerable size there are evidences of glacial drift. In this bog occurs the white-leaved willow (*Salix candida*) and a few other northern bog plants, like *Menyanthes trifoliata* and *Gentiana crinita.* At present the bog is being drained by a large ditch that has cut its way through for a considerable distance. In the peat which falls into this ditch there have been found several large buffalo skulls.

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* Myron is an old P. O. station on the Yellow River, now discontinued.

FASCIATION IN THE CHERRY.

BY JACOB SCHNECK, M.D.

The accompanying illustration gives examples of fasciation in two vigorous sprouts of wild black cherry (*Prunus serotina* Ehrh.), which appear to be of especial interest, from the light they may throw on the question of the nature of this phenomenon in plant life.

It has been claimed that fasciation, in plants, is a " monstrous expansion, caused by the coalescence of several stems in one plane," or a " deformity caused by a diseased growth, from the sting of an insect." The latter view has more to do with the cause than the nature of the phenomenon.

The specimen on the left has the appearance of complete adhesion of all the component branches. The striae are probably not the lines of union; but more likely are the continuation of the outlines of the fibro-vascular bundles, leading from the superposed leaves and buds, down the common stem. On close inspection each stria is found to lead up to a bud or leaf. The specimen on the right is doubly interesting, showing in the lower portion complete adhesion, while in the upper portion some of the members of the fascicles have separated themselves into distinct branches, and have continued to grow in the normal way. The sidewise curling is probably due to the greatly retarded growth on the side toward which it turns; while the growing points on the other side kept up a vigorous development in line with the general axis of growth, and so become separated from the other parts. The side towards which the curve turns is much thinner than the one on which the vigorous growth took place.

Cross-sections of these specimens show that the pith cylinders have all united and formed one long flat pith-cavity, as far as the adhesion is complete. The rational deduction appears to be that a *fasciation* is the coalescence of some or all of the growth, of the growing points, of a given plant or branch. Had not these adhesions taken place our specimens would probably have been vigorous young trees, with from twenty-five to perhaps one hundred thrifty branches.

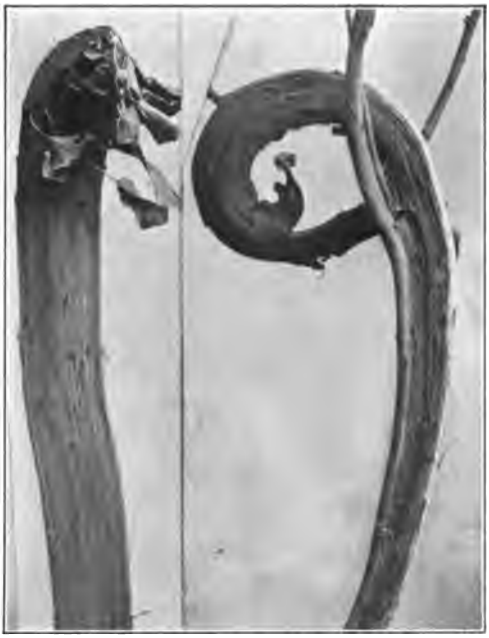

FIG. 14.—Fasciated cherry twigs.

A TROPICAL WATER PLANT.*

The Fluviales constitute one of the most interesting and fruitful groups for study in the whole plant kingdom not only from a morphological, but from an ecological standpoint. A Swedish botanist, Dr. Svedelius, has added another interesting contribution to our knowledge of the group. His observations were made during 1902–03 while on the island of Ceylon where *Enalus* and several others of the tape-grass family are found. *Enalus acoroides,* like the familiar fresh-water eel-grass (*Vallisneria*), is one of those hydrophilous plants which effect pollination by the breaking off of the staminate flowers under water, by their rising to the surface and by their floating to the pistillate flowers.

Svedelius finds that in both stem and root the vascular system is poorly developed. The vessels are few and not lignified. The cortex is strongly developed and the internal layers are filled with huge starch grains. Many tannin cells occur throughout the vegetative tissue, also in the pedicels of the staminate flowers. They are also found in great abundance in the perianth of the pistillate and to a less degree in the perianth of the staminate flowers.

The single pistillate flower, as well as the large cluster of staminate flowers, is surrounded by a double spathe which in the former has much to do with pollination. The bud formed by these spathe leaves is about five cm. long by three cm. in diameter in the case of the staminated inflorescence, while in the case of the pistillate flower the diameter is but one cm. A large number of staminate flowers are attached by long slender pedicels to a common axis. At the period of flowering the spathe leaves open a short distance at the top, their edges rolling back slightly, the pedicel ruptures, allowing the globular bud, filled with gas, to ascend to the surface. Upon reaching the surface the six-parted perianth opens explosively, owing to the release of water pressure, leaving the three almost sessile anthers above the level of the water. The pollen grains are very few, only about 100 to each anther, but a large output is secured by the production of a large number of staminate flowers on each axis. The pollen grains are smooth, very large, 175 μ, contain oil and starch and are heavier than sea water.

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* On the Life-history of *Enalus acoroides* (a contribution to the ecology of the hydrophilous plants), by Nils Svedelius. Ann. R. Bot. Gard. Peradiniya **2**: 267–297. Aug. 1904.

At low tide pistillate buds are above water and at anthesis the hairy spathe leaves open and the whole inflorescence rests with its axis in a horizontal position upon the water. The perianth of the pistillate flower consists of three short sepals and three long reddish petals, the latter being much folded both longitudinally and transversely as a result of much growth while being confined by the sepals. These folded petals extend beyond the spathe leaves after they have opened. The stigmas are sessile upon the six-lobed ovary. The six parietal placentae split early, forming large air cavities which aid in floating the flower until the growth of the embryos fills the cavities and increases the density of the whole organism, causing it to sink to the bottom after the ovary has been shed.

Being a marine plant and subjected to tidal changes, the problem of pollination with *Enalus* is much more complex than with many other hydrophilous plants. As stated above at the time of pollination the pistillate inflorescence is floating with its axis in a horizontal position with the extended petals resting upon the surface of the water without becoming wet. As the staminate flowers float about on the water in large numbers some of them are caught by the curious folds in the petals of the pistillate flowers and held fast in spite of wind and currents. With the rising of the tide the pistillate inflorescence is submerged and its axis takes a vertical position. The heavy pollen then drops upon the stigmas. From the above it will be seen that the first step of pollination is effected only during low tide while the second takes place during high tide. Before separating from the plant under water the perianth of the staminate flower forms a balloon-like body enclosing a bubble of gas. The density of this gas, of course, depends upon the depth of the water. It is evident, therefore, that during low tide the specific gravity of the whole flower is less, causing the pedicels to rupture at that time. " Thus there is in this plant a remarkable correlation between the exposition of the pistillate flowers and the loosening of the staminate flowers, in that both these phenomena always occur at the same time, during low water." Wylie in working with the hydrophilous *Elodea,* recently, also observed a periodicity in the detachment of the staminate flowers, though of course from a different cause, as *Elodea* is a fresh-water plant. After fertilization the fruit is pulled entirely under water by the spiral twisting of the pedicel.

Owing to the large development of mucilage in the ovary, Svedelius was not able to study sporogenesis or the development of the gametophytes. True to the ordinal character of the Fluviales very little endosperm is developed.

Another remarkable character of the plant is its viviparous habit. The term " viviparous " is used here not in the sense that it was used by earlier botanists in regard to the grasses. *Enalus* " can scarcely be considered to have any seeds, because it is the young embryos which are dispersed at the opening of the fruit." Thus there is no resting stage in the plant, for the embryos are shed while they are still in process of development and dropping to the mud continue to grow. Therefore we have a case of true vivipary such as F. E. Lloyd reported for *Podocarpus* and Kerner for various mangroves, though in the case of *Enalus* the embryos do not develop as long upon the plant as they do in the mangroves and *Podocarpus.* I. D. C.

THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

REPORT OF THE PRESIDENT FOR 1904.

To the Members of the Wild Flower Preservation Society:

The question may arise as to what need there is of a movement for the preservation of the wild flowers of America. Why do we need to preserve the wild flowers? There are men in every community who would not miss the wild plants should they all be blotted out, but these are men who have no conception of the use of the beautiful. We should conserve these shy plants, each having its own type of beauty, for the beauty which they have alone. While I am to a very considerable extent a utilitarian, I shall still feel that the perfection of utilitarianism includes the beautiful. A thing is useful through its beauty, in adding to the attractiveness of the landscape, and of the surroundings of the place in which we live.

Further, we should preserve as far as possible the original plants of the country, in order that we shall not disturb too greatly the other living things in the great biological kingdom. The extinction of a single plant may mean the driving out of certain attractive birds which feed upon the seeds of the exterminated plant. If we should allow the wild flowers to be indiscriminately exterminated we should at the same time drive out a host of birds dependent directly or indirectly upon them.

I think we may appeal also to a higher reason for the conservation of the wild plants, and that is the scientific interest which every one of scientific training has in these plants. Year by year the community is becoming more and more interested in scientific matters and it is not too much to hope that the point of view of the scientific men may eventually become the point of view of the community in general; and therefore we may make the appeal of the scientific interest that these plants have, and for this reason insist upon their preservation.

I wish also to speak of the duty we owe to those who come after us. We find the world containing certain beautiful and interesting plants. We should not exterminate these, but permit them to live so that those who follow us may find them still growing where they can be enjoyed. Posterity has claims upon us and we have no right to treat the plants of the world as though no others were to follow us.

I am sometimes met with the statement that very few plants are in danger of extermination, and I am glad to say that this is true, and there are very many places where perhaps no plants are in danger of extermination. Yet it is true that here and there particular plants are seriously in danger. A few examples from my own experience may be helpful at this time.

In Colorado, near Pike's Peak, are some very beautiful canyons.

They are still beautiful in spite of the fact that from most of them the more delicate plants have been entirely exterminated. In South Cheyenne Canyon, for example, there are to-day very few ferns, and yet it is not so many years since the canyon was noted for the beauty of its fern vegetation. These ferns have been ruthlessly destroyed by tourists who wanted plants to carry for an hour or two, and then to throw away. This canyon has been very greatly injured in its beauty by the destruction of these delicate ferns.

A number of years ago it was my good fortune to visit a little dell in the Harney Peak region of the Black Hills, in South Dakota. The party with which I went was the first which had ever visited the place. Certain hardy prospectors had been there, but no party of "outsiders" had been there before we went. We found a beautiful bed of mosses covering a number of square rods. I do not think I have ever seen in any place in the world a prettier sight than that of these tall Pogonatums with their rich dark green color. There were several children in the party, and they rolled over this beautiful moss in ecstasy, and even the grown people felt that they were in a most romantic dell. We did not injure the mosses, but the next day a party of "tourists" followed our track, and one of the women who came back showed us with great glee a large mass of this beautiful moss rolled up as one would roll up a mat. She had ripped up these things of beauty, and torn them ruthlessly from where they had grown for years. We were so intensely disgusted with this vandalism that we showed our indignation very plainly. She undid in five minutes the work of perhaps many decades.

I once knew in central Iowa a big bog full of the rich lady slipper (*Cypripedium spectabile*) which bloomed from year to year in great profusion, but it was near to a college, and the students took more and more of the specimens away, and finally an eastern botanist wishing roots of this plant, was supplied with them, and apparently the whole bog was denuded of them. I visited the place some years afterwards and found not a trace of these fine orchids. Apparently a large, showy plant is much more likely to be exterminated than one which is less showy.

Perhaps I should add to the plants that are in danger of extermination the few cases of groves of great trees. In many parts of the country there are such clusters of trees of gigantic proportions and of marked interest, but those that are best known are the big Sequoias of California, and I feel that this society should lend a hand in trying to save these great trees. An effort is now being made by the Women's League of California to preserve these groves of great trees by having them set aside as national reservations. I recommend that we do all that we can to aid in the passage of the bill which is now pending in Congress.

What can we do to further our aims? It seems to me that one of the most effective things is the securing of government reservations, not only for the big trees of California but for other choice woodlands. The practice, which is now growing, of setting aside government forest reserves is one that should be encouraged. Wherever a great reservation is made the trees and shrubs and herbaceous plants will be much more certainly preserved. If in the South Allegheny Mountains a great reserve is set aside there will be kept at the same time not only the forests but the many other plants which live in them. I should like to see the same general government supervision of these reserves with regard to the vegetation therein, that we have in the Yellowstone National Park with regard to the animal life. What the government has succeeded in doing in the preservation of wild animals it could do also in regard to the preservation of wild plants. If we have a considerable number of these reserves scattered over the whole country we shall succeed in preserving for all time a number of plants that otherwise seem destined to extinction.

There are other suggestions that might be made, but in this short communication I think I may well stop with what I have already said.

Wishing the Society the greatest of success in the future, and urging the members to be loyal to the purposes of the organization, I am,

Very truly yours,

CHARLES E. BESSEY.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

It is not intended to make the Teachers Department a department of pedagogy. It is not for teachers in general, but rather for the teacher of botany in particular. Good botany teaching involves an intelligent comprehension of the underlying principles of instruction, combined with a thorough knowledge of botany and a lively interest in the science. Journals of pedagogy must deal with the former. It is the purpose of this department of the PLANT WORLD to foster the latter. Logically it is a department that ought to be maintained by teachers, and to them we freely offer our columns. We shall be glad to receive short notes and longer articles that will in any way help to the better teaching of botany. A description of a new experiment, a new piece of apparatus or a modification of something old, new material to demonstrate certain points, helpful suggestions for field and laboratory work, or anything of a like nature will all be of interest to a live teacher.

We shall be glad, also, to welcome from teachers questions concerning anything that pertains to the teaching of botany in high school or normal school, and will endeavor, as far as possible, to publish answers to such queries. As far as practicable we shall be glad to print articles on topics specially asked for. We invite all teachers of botany who read the PLANT WORLD to aid us in making this department practical and helpful.

FOR THE DEMONSTRATION of positively geotropic shoots in winter, *Bryophyllum crenatum,* a near relative of the well-known species *B. calycinum* which produces new plantlets from the sinuses of the crenate leaf margin, is especially suitable. The plants bloom here,* for the most part, about the middle of November but can be held back for a considerable period by cultivation at lower temperatures. Usually, in winter time, the only plant shoots at hand which are positively geotropic, are the flowers of *Cyclamen persicum* and other species. These are, however, but poorly adapted for demonstration in the class or lecture room. ***Bryophyllum crenatum*** has the advantage that the entire upper end of the hitherto strongly orthotropous leafy shoots become reversed in position as soon as the formation of the inflorescence begins, until finally the tip of the axis becomes directed downwards. By reversing the plant, it is easily shown that here is an example of positive geotropism. When the flowers are further developed, changes take place which result in the resumption of the upright position, that is, the negatively geotropic one.

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* In the greenhouses of the Botanical Institute at Munich, Germany.

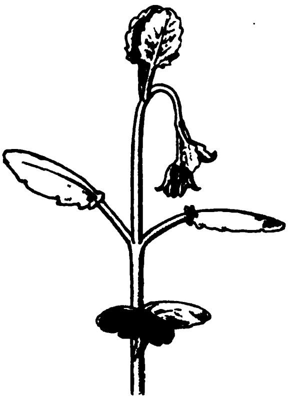

FIG. 15.—Positively geotropic shoot of *Bryophyllum crenatum* as flowering begins.

The plant in question (which may be obtained from dealers) is easily cultivated, more so indeed than *Bryophyllum calycinum,* and is of further interest on account of the fact that it too produces buds on the leaves. It therefore well deserves a place among the useful materials of the botanical laboratory. (K. Goebel. Flora, **94**: 205. 1905. Translated by F. E. L.)

THE RELATION OF SALTS TO NATURAL VEGETATION.—Dr. Burton E. Livingston (Bot. Gaz. **39**: 22. 1905) has continued his former studies of this subject in Roscommon and Crawford counties, Michigan. Two general types of vegetation are distinguished:

(1) The Upland Type, consisting of (*a*) hardwood type; (*b*) white pine type; (*c*) Norway pine type; (*d*) jack pine type.

(2) Lowland types, comprising (*a*) open meadow type; (*b*) tamarack-arborvitae type; (*c*) mixed swamp.

His researches lead the author to the conclusion that forest distribution in the region studied is a function mainly of the size of soil particles. "The size of particles determines the amount of air and moisture in the soil, and these in turn determine the amount of humus formation and the growth of nitrifying organisms, and perhaps also to a certain extent the amount of soluble salts in the surface layers."

Distribution on uplands along swamp borders is also determined in part by the nearness of the underground water level to the surface. The classification of vegetation as upland or lowland depends upon this factor. Local distribution of the vegetation is subject also to physiographic control.

In connection with this paper may be mentioned the conclusions of Whitney and Cameron (U. S. Dept. Agri., Bureau of Soils, Bull. 22, 1903) that, "there is no obvious relation between the amount of the several nutritive elements in the soil and the yield of crops," but that, "the actual quantity of water a soil can furnish a plant, irrespective of the percentage of water actually present in the soil, has probably a very important influence on the yield."

This supply of water to the plant would depend upon the coarseness or fineness of the soil, as has been shown experimentally by Livingston and Jensen (Bot. Gaz. **38**: 67. 1904).

C. S. G.

The Protection of Winter Buds.—A very common misconception has gained currency concerning the purpose of certain structures in winter buds. It is very pretty poetry to speak of the "baby plant, snugly wrapped in its warm blanket to keep it from freezing"! but any one may readily demonstrate the fallacy of the idea on any winter's day when the temperature is below freezing. If horse-chestnut or other buds are cut open on such a day they will be found packed with ice and the bud itself frozen. Evidently the "warm blanket" must serve some other purpose than the prevention of freezing. What is this purpose?

It is a well-known fact that frozen plants may frequently be saved by allowing them to thaw while immersed in water. Loss of turgor does not then take place and the freezing is not fatal. Similar factors are involved in the ecology of winter buds. When a cell is reduced to the freezing temperature water leaves the cell and solidifies in ice crystals outside the cell wall. If the cell or cellular tissue is freely exposed to the air the water evaporates when a rise of temperature melts the ice. Plasmolysis thus becomes permanent and the frozen tissue dies. The protection afforded by the bud coverings prevents evaporation when the ice melts, the water is then reabsorbed by the cells, turgor is regained, and thus the bud may safely experience several freezings and thawings. C. S. G.

REVIEWS.

LIFE HISTORY OF PINUS.

Students of morphology, already familiar with Dr. Margaret C. Ferguson's (1901, 1903) work on *Pinus,* will welcome her "Contributions to the Knowledge of the Life History of Pinus with Special Reference to Sporogenesis, the development of the Gametophytes and Fertilization." This book embodies the substance of her former papers together with the results of her further study of the pines. It is a volume of 202 pages and twenty-four handsomely executed plates, and is published as Vol. 6 of the Proceedings of the Washington Academy of Sciences. The work was given especial honorable mention on April 26, 1903, by the Association for Maintaining the American Women's Table at the Zoological Station at Naples and for Promoting Scientific Research by Women. While, as the author states, "mere mass work does not signify excellence," still one's confidence in Dr. Ferguson's results is greatly increased by the fact that her research involved the imbedding of "nearly six hundred paraffin blocks," and the study of "more than four thousand slides of serial sections." The study of "more than two thousand pollen tubes" would certainly be more likely to reveal the general truth concerning the sequence of events in their development than would the study of three or four hundred which more nearly represents the usual extent of observations in research work. It is hardly possible to overemphasize the need of putting up and studying large quantities of material.

The five chapters treat of microsporogenesis, the male gametophyte, macrosporogenesis, the female gametophyte, fertilization and related phenomena. Abnormal conditions are treated in an appendix.

The archesporium is not found in *P. strobus* until May, but in most other species it develops late in the fall. Qualitative reduction of the chromatin occurs during the second division of the pollen mother cell. The sperm nuclei, resulting from the division of the "generative cell" do not organize separate sperm cells, but are free in a common mass of cytoplasm, thus forming a binucleate cell. One sperm nucleus is larger than the other.

The formation of archegonia precedes fertilization by about two weeks. During fertilization there is no fusion of the male and female chromation, and during the first cleavage of the fertilized egg the two groups of chromosomes remain distinct on the spindle.

Any adequate review of the paper is beyond the limits of space at our command. It is by far the best work that has been done on *Pinus*. C. S. G.

NOTES.

WE PUBLISH THIS MONTH in addition to the regular matter a Supplement containing an account of the first week-long field meeting of botanists ever held in this country. In addition to the intrinsic interest of the material presented the record will certainly be of great historic interest in the future.

"THE ESTABLISHMENT during recent years of biological stations in various parts of the world has proved to be of the greatest importance in furthering the progress of science. The great station of Naples has now a worthy competitor at Wood's Hole, and the botanical laboratory at Buitenzorg is aptly represented in this country by the Carnegie Desert Laboratory. The already large number of lesser institutions of similar nature is rapidly increasing, both in this country and abroad, and all add to the opportunities available for the working biologist. Up to the present time the foundation of such stations has been confined, however, to regions with temperate or tropical climate, and no attempt has been made to establish a permanent station for biological research within the Arctic, until recently. A Danish botanist, Morten P. Porsild, has proposed to his government the appropriation of funds for such a station, to be located on the southern coast of Disko Island in North Greenland, not far from the colony Godhavn (lat. 69° 15′ N.). . . . The geographical position of Greenland, and the similarity of conditions there with those of the northernmost part of this continent must necessarily appeal to Americans, and until the time arrives when a permanent biological station can be established in a suitable locality in Alaska, those engaged in arctic work will find the now proposed institution a place of interest."—Pehr Olssen-Seffer, in Science, February 3, 1905.

THE SECOND ANNUAL MEETING of the American Breeders' Association, under the Presidency of the Honorable Secretary of Agriculture, James Wilson, was held at Champaign, Ill., February 1, 2 and 3, 1905. Especially prominent in point of importance were the several papers dealing with the breeding of strains of plants resistant to disease. This indicates that intelligent attention is being given to the problem of 'preventive medicine,' if we may so denominate it, in the plant kingdom. The theory of heredity too occupied a goodly share of attention. The Association, though young, promises to become a permanent and important institution. There are already between four and five hundred members.

THE PUBLICATION of *School Science and Mathematics,* temporarily discontinued since last summer, has been resumed under the editorship of Charles H. Smith, of the Chicago High Schools. There are six departments represented, of which one, that of Biology, is edited by Professor Otis W. Caldwell, State Normal School, Charleston, Ill. Vol. 5, No. 1, January, 1905, has appeared and contains the following papers of interest to teachers of botany. 'Apparatus for the Measurement of the Growth of a Plant,' by G. W. Low; 'Report of Committee on Biology'; an 'Aquarium' (of Simple Construction), by W. W. Whitney; 'Is Silphium perfoliatum a Carnivorous Plant?' by N. A. Harvey; and 'Bacteriology in the Public Schools,' by W. H. Manwaring.

WE ARE INFORMED that from now on *The Mycological Bulletin* will be published at 25 cents a year instead of 10 cents as heretofore. The size has, however, been increased from twelve to twenty-four numbers a year. Subscriptions should be sent to Professor W. A. Kellerman, Columbus, Ohio.

Volume 8 SUPPLEMENT Number 2

The Plant World

A Magazine of Popular Botany

FEBRUARY, 1905

REPORT OF A BOTANICAL SYMPOSIUM HELD AT McCALL'S FERRY, PA., JULY 1, 1904.

At a joint meeting of the Torrey Botanical Club with the Philadelphia and Washington Clubs, at McCall's Ferry in the Susquehanna River Valley, York and Lancaster Counties, July 1, 1904, is was unanimously declared that the Symposium of American Botanists there inaugurated become an annual occasion of a week's duration, at a locality selected at the previous meeting and publicly announced in the botanical journals.

As the simplest form of organization it was resolved to elect a chairman each evening but to have a permanent recorder.

The object of the symposium is twofold: one scientific, the other social, the latter to extend acquaintanceship among botanists by a week's sojourn together, and the former to investigate plant life in the region visited and to discuss botanical subjects in general.

As we reached the ferry quite late on July 1, all field work was practically out of the question for that day. Saturday morning was spent along the river bank south of the house, probably for a mile and a half or so, and the afternoon northwards along the river and towpath to Duncan's Point for about the same distance.

In the evening Dr. Nathaniel Lord Britton was elected to the chair and Joseph Crawford, recorder.

Discussions of ash trees noticed during the day was the first topic taken up. Some good fruiting forms of *Fraxinus lanceolata, F. Americana* and *F. Pennsylvanica* were examined. Search had been made during the day for *F. Darlingtonii* but without success. *Fraxinus Biltmoreana* found this season by us near Trenton, N. J., was not noticed here, though it had been found by Dr. John K. Small in this locality about ten years ago. Its fruit differs from that of *F. Americana* or white ash by its shorter body and longer and broader wing, and by its velvety pubescent foliage.

Mr. Crawford described the work of the day by calling especial attention to the flourishing forms of *Asplenium montanum* on a large rock above the hotel where it had been practically unmolested for twelve years. It is the most generally distributed of the small rock-inhabiting ferns in the valley.

Filix bulbifera was luxuriant on a few rocks below the house; nearby were noticed for the first time in York County a goodly number of young plants of *Passiflora lutea*.

The late Dr. Thomas C. Porter had reported this from Tucquan, just above this place, also at Safe Harbor, which is perhaps its most northerly limit.

A few scrawny fronds of *Pellaea atropurpurea* were also seen on a river rock along shore, being a rarity also in this neighborhood with no limestone to flourish upon.

Messrs. Samuel Van Pelt and Albrecht Jahn made mention of the large colonies noticed in the afternoon stroll of *Synosma suaveolens* and *Silene alba* and smaller ones of *Mesadenia reniformis* and *M. atriplicifolia,* also a few plants of a climbing vine with strongly white striped leaves which suggested *Gonolobus laevis* Michx., a rare plant indeed for this region.

Rhododendron maximum was very abundant on the sheltered rocks and gorges in the hillsides, though flowering very sparingly in the latter situations.

Carex Caroliniana was a sparsely distributed sedge but with very ripe fruit.

The following day was spent in the vicinity of the " Slab " and " Broad Water," two miles south, where the canal was formed by appropriating a rocky and picturesque channel of the river and heavily walling it up, but which the Susquehanna has since reclaimed by some of its wonderful forces of ice and water and devastated to a dangerous degree even for persons afoot.

It is a very good botanical region and the low stage of the river at this time permitted easy access to the large wooded rocky islands very numerous at this point.

In the evening Dr. Britton was again elected to the chair and the following notes were announced.

Dr. Britton spoke on *Betula Allegheniensis,* a recently described but well marked species associated with *B. lenta* and *B. nigra* along the river and hillside ravines.

In observing these birches particular reason was shown for frequent field work. These three species were often growing either side by side or within easy eye range of each other and their specific characteristics of growth and general outline, color and condition of bark, of trunk and twig, leaf shape and shade of green were all so evident to the eye in these living examples, yet more or less difficult of recognition from descriptive comparisons in handbooks or herbaria. Dr. Britton showed also other specific variations in the hackberries, two of which were recognized as *Celtis canina* and *C. crassifolia.*

Dr. Valery Havard spoke of the persistence of *Solidago Purshii* on the shore rocks, notwithstanding the late terrific devastation by ice and water. He also called attention to the variations of *Knieffia fruticosa* in its fruit and pedicels.

Mrs. Britton and Miss Mulford were of the opinion that the prevailing *Houstonia* was certainly different from ordinary forms of *H. purpurea* or *H. longifolia.* Upon investigation Dr. Britton discovered it to be densely papillose-glandular, with other marked characteristics.

A very fine clump of *Carex scabrata* was also reported.

Mr. Van Pelt and Mr. Crawford reported a great colony of tall terrestrial *Isoetes* out on the high rocks opposite the Slab. They had the same general appearance as *Eleocharis Engelmanni,* due to the length of the erect and rigid leaves. The only species approaching it in general character, *I. Engelmanni valida,* was reported some years ago from vicinity of Smithville, Lancaster County, some distance away. (The river plant was sent to Professor Eaton for identification and promptly referred to *I. Canadensis.*)

Mrs. Britton discovered on an adjoining wooded island the ostrich fern, *Matteuccia Struthiopteris*, in great profusion.

Dr. Britton exhibited a number of specimens of viburnum twigs with stellate pubescence which he referred tentatively to *Viburnum semitomentosum.*

Mr. Crawford noted *Phegopteris polypodioides* on canal wall at Broad Water. Mr. Williamson met with a large patch of *Hibiscus militaris* at this place also and Mr. Jahn other colonies of the Ostrich Fern.

The recorder regretted having to report the entire disappearance of *Asplenium Bradleyi* from its locality at the " Slab," as it is much less frequent on the York County side of the river.

Monday, July 4, was spent working along abandoned canal, towpath and river to York Furnace, three miles north.

The following report was made in the evening, Professor Britton being in the chair.

An exceedingly curious crucifer was reported from Duncan's Point, evidently an introduced *Brassica,* about two feet high with large clasping upper leaves and long beaked pods. The same point was the most abundant station for *Heuchera Curtisii,* growing everywhere in great profusion on exposed rocks and wall of canal. This species has been lost sight of for many years, but is now known to extend northward into New York.

Hypericum Ascyron was more or less abundant near the river and this location gives it a southern extension of its cited range.

Smilax hispida and *S. pulverulenta* were frequent in a little woody clump just below the Furnace, associated with the green violet, *Cubelium concolor, Galium concinnum, Carex Jamesii* and *C. pubescens,* and in a nearby ditch *Carex tribuloides Bebbii.*

This little clump of woods proved very interesting from the fact that a great portion of its timber was hackberry. All were large fine vigorous trees of which the long leaved forms of *Celtis crassifolia* and *C. canina* were very prominent. *Hydrophyllum Canadense* was there in good fruiting condition.

Sida hermaphrodita still maintains its stronghold by the canal bridge at the Furnace, also at Schenck's Ferry, a few miles up the river, probably its northern limit. A strange feature of this plant is that in all the twelve years some of us have had it under observation no seedlings have ever been seen from the Furnace plant.

A short trip up Kevinski Glen was taken to show growing forms of *Asplenium pinnatifidum, Viola villosa, Leptorchis liliifolia* and *L. Loeselii.* The latter two were in good flower.

Phyllanthus Carolinensis was also abundant at Furnace along sandy banks of river, and on hillsides.

Kevinski Glen also contains perhaps more plants of *Magnolia tripetala,* the umbrella-tree, than any other locality in the valley. This is about its northern limit.

Parietaria Pennsylvanica and *Rubus Allegheniensis* also appear here.

Dr. Britton called attention to a hackberry which proved to be *Celtis Georgiana* Small and noted for the first time in this latitude.

It is a low tree with irregular branches, very much the aspect of *Celtis occidentalis* but with small leaves, short petioled, obliquely ovate, short, acuminate and rough, fruit globose and short peduncled. Nearby on border of woods were the usual large, long acuminate leaved species noted before, *C. canina* and *C. crassifolia.* The contrasts were strikingly interesting.

Large beds of *Sedum ternatum* covered the rocks in shaded portions even when pretty well taken up by the walking fern, *Camptosorus rhizophyllus.*

In the oak woods at Furnace two species of cow wheat were found, *Melampyrum lineare* Lam. and *M. latifolium* Muhl.

On Baer's Island opposite Furnace Hotel the following plants were prolific, *Boltonia asteroides, Hibiscus militaris, Physostegia denticulata, Carex squarrosa* and *C. cristatella.* A former plant of the region, a frequenter of slow moving water, *Potamogeton pectinatus,* the fennel-leaved pondweed, has disappeared with the general decay of canal life.

Mrs. Britton reported from Otter Creek *Byrum proligerum* and *Aphanorrhegma serratum.*

On Tuesday a rocky gorge below McCall's Ferry station and near Fite's Eddy was explored with very little result except some hard climbing over projecting rocks and wading in the rushing stream. However, the following report was made at the evening's symposium, with Dr. Britton again in the chair.

Mr. Jahn noted great abundance and fine condition of *Silphium trifoliatum* along the river at the mouth of this gorge. Mr. Van Pelt found several good clumps of *Uniola latifolia* near same location. Dr. Waters reported numerous large colonies of *Conopholis Americana* on sides of the gorge. This plant invariably appears in these great clusters around its host, no single or individual plants appearing from seed, yet judging by its large spikes of fruit it is an abundant seed producer. A specimen obtained from this region a number of years ago by the Philadelphia Botanical Club showed from 75 to 100 shoots clustered around one point of contact and nearly ending the life of the host's root at that point.

Dr. Joseph N. Rose showed extension in range of *Apocynum hypericifolium*. A good species separable from *A. Cannabinum* by its pure white flowers instead of greenish white, and glaucous cordate clasping leaves instead of green petioled ones.

Professor Sumstine reported finding in abundance on the woody hillside near Cully's Station a white fruited strawberry, which was round and about 1 cm. long and neither conic nor pink as in the common strawberry *Fragaria Americana.*

Dr. Britton noticed *Morus rubra* in Mud Run and Mrs. Britton the following mosses: *Hypnum Boscii, Thamnium Allegheniensis* and two species of *Leucobryum* from same gorge.

The recorder reported on the good condition of the rare fern *Asplenium Bradleyi* on large sheltered rock by river's edge noticed by him and Mr. Brown some years previously. The species was maintaining its individuality in an oblique seam of the rock and in parallel seams *A. pinnatifidum* and *A. platyneuron* were doing the same. He also made note of the abundance in the upper portions of the gorge of *Carex costellata.*

Dr. C. E. Waters showed some fronds of *Asplenium platyneuron,* producing new plantlets near their bases. This condition had been found before, but infrequently.

Dr. Britton found other shrubs of the stellately pubescent *Viburnum,* showing it to be well distributed in the valley.

A fine type of the common hackberry (*Celtis occidentalis*) was noted near the boat landing.

Wednesday, July 6. The morning was spent about the wooded islands and bottoms about the house and between canal and the river and the afternoon in ascending Rhodendron Ravine, west of the house.

Dr. Joseph N. Rose took the chair in the evening.

Dr. Britton itemized *Callitriche Austini* and *Tissa rubra* and, in a small pool out on the rocks, a colony of *Eleocharis,* absolutely nothing else appearing in the pool but five species of this genus, namely: *E. acicularis, E. Engelmanni, E. palustris, E. palustris glaucescens* and *E. Smallii.* McCall's Ferry is one of the original localities for the last named.

Messrs. Jahn and Van Pelt reported *Coreopsis tripteris, Allium cernuum* and *A. Canadensis,* the latter two in fruit only; also *Cardamine rotundifolia.*

Dr. Waters found one clump of *Phegopteris polypodioides,* this making the second locality known between Columbia and Havre de Grace.

The knieffias along the shore section were very puzzling and they elicited considerable discussion on the part of Messrs. Carter, Britton, Nash, Price and Rose by their variability in fruiting forms.

Mr. Painter showed a good species of *Sagittaria rigida* from the canal; he also exhibited fruits of *Galeorchis spectabilis.*

Miss Mulford spoke of the frequent occurrence of a decidedly red tinge to the stems, petioles and tips of flowers in a great number of plants of *Circaea lutetiana,* but beyond this pigmentation there seemed no specific differences.

Dr. Britton referred to a broad leaved *Rudbeckia* found on one of the islands in the river. He also described more fully the hackberries of the region, dwelling at length on *Celtis canina* of Rafinesque. This is distinguished from *C. occidentalis* by its larger leaves, which are gradually acuminate instead of abruptly so and is a plant of the woodlands rather than rocky ledges. *C. crassi-*

folia differs from others by its scabrous leaves, which are merely acute instead of acuminate.

Mr. Brown, just returned from Florida, related some interesting experiences on the keys.

Dr. Britton drew attention to *Cardamine flexuosa* With. and spoke of its relation to *C. Pennsylvanica, C. hirsuta* and *C. arenicola* and in its general aspect differing so considerably from other American forms.

Dr. Waters reported typical *Dryopteris spinulosa* and its variety *fructosa.* He also obtained with little difficulty more individuals of proliferous *Asplenium platyneuron,* altogether some ten fronds.

Dr. Britton gave an interesting account of Professor de Vries' experiments on the genus *Onagra* and he suggested that perhaps the same principles could be applied to the genus *Knieffia.*

Thursday morning was devoted to exploring Tucquan Gorge, two miles above McCall's Ferry Station, and in the evening Mr. Stewardson Brown occupied the chair.

Mr. Nash discussed the great number of panicums in the valley, notably *P. polyanthes, P. sphaerocarpon, P. linearifolium, P. depauperatum, P. unciphyllum* and at least two unnamed species. *Uniola latifolia* reaches its northern limit at this place. Mr. Nash also gave an enjoyable account of some of his recent Florida experiences.

Other plants worthy of record found during the day were *Ilysanthes attenuata, Veronica scutellata, Scutellaria cordifolia, Meibomia Canadensis, Solidago Canadensis* and var. *glabrata* and *S. juncea.*

Friday was spent in retrospection by those who were able to remain. It soon came time to quench the council fires which had burned on Algonquin Rock. The hearty thanks of the visiting botanists were extended to their very genial and kind-hearted host and hostess, Mr. and Mrs. Elias W. Urey, who so cheerfully gave over their entire house to their disposal.

Thus ended the first Symposium of Botany on the Susquehanna, which was adjourned to meet about the same time in July of 1905 in the Allegheny Mountains at Cresson, Pa.

The following botanists were present.

Dr. N. L. Britton, New York City; Mrs. N. L. Britton, New York City; Stewardson Brown, Philadelphia; Joel J. Carter, Peter's Creek, Pa.; Joseph Crawford, Philadelphia; Miss Nellie Hewins, New York City; Dr. Valery Havard, West Point, N. Y.; Albrecht Jahn, Philadelphia; J. B. Kevinski, Lancaster, Pa.; Arthur N. Leeds and Morris E. Leeds, of Philadelphia; O. R. Medsger, Newark, N. J.; Miss Frances Mulford, Hempstead, L. I.; Geo. V. Nash, New York City; Professor Ferris W. Price, Swarthmore, Pa.; Joseph H. Painter, Dr. Joseph N. Rose and Master Joseph S. Rose, of Washington, D. C.; Professor R. C. Schiedt, Lancaster, Pa.; Professor D. R. Sumstine, Kittanning, Pa.; Samuel S. Van Pelt, Philadelphia; Dr. C. E. Waters, Baltimore, Md.; Professor C. S. Williamson and Lee Sowden, of Philadelphia.

The following sent letters of approval but regretted their inability to be present at the meeting: Dr. Geo. N. Best, Rosemont, N. J.; Eugene P. Bicknell, New York City; Dr. Henry C. Chapman, Philadelphia; Willard N. Clute, Binghamton, N. Y.; Miss Myra L. Dock, Graeffenburg, Pa.; David F. Hoy, Ithaca, N. Y.; Thomas H. Kearney, Washington, D. C.; Rev. L. H. Lighthipe, Orange, N. J.; E. L. Morris, Washington, D. C.; J. E. Overholtzer, Norristown, Pa.; T. Chalkley Palmer, Media, Pa.; A. A. Eaton, North Easton, Mass.; E. L. Rand, Boston; Dr. Joseph T. Rothrock, West Chester, Pa.; Dr. H. H. Rusby, Newark, N. J.; C. F. Saunders, B. H. Smith and Witmer Stone, of Philadelphia; Professor C. O. Thurston, Kingston, Pa., and Dr. Horatio C. Wood, Philadelphia.

JOSEPH CRAWFORD,
Recorder.

As the region is noted more or less for mingling of plants from various points of the compass, it is deemed advisable to append a list of them at this time, so far as known to date, from collections, from the record of the Philadelphia Botanical Club 1892, and from individual lists from such eminent observers as the late Dr. Thos. C. Porter, E. R. Garber, Joel C. Carter, Ferris W. Price, John K. Small and A. A. Heller.

Pellaea atropurpurea (L.) Link.
Cheilanthes lanosa (Michx.) Walt.
Asplenium pinnatifidum (Nutt.).
    ebenoides R. R. Scott.
    angustifolium Michx.
    montanum Willd.
    Bradleyi D. C. Eaton.
Camptosorus rhizophyllus (L.) Link.
Phegopteris Phegopteris (L.) Underwood.
    Dryopteris (L.) Fee.
Filix bulbifera (L.) Underwood.
Matteuccia Struthiopteris (L.) Todaro.
Equisetum sylvaticum L.
    littorale Keuhl.
    fluviatile L.
Isoetes Canadensis A. A. Eaton.
Pinus Strobus L.
    pungens Michx.
Potamogeton lonchites Peck.
    zosteraefolius Schur.
    pectinatus L.
    Robbinsii Oakes.
Sagittaria rigida S. Watson.
    subulata (L.) Buch.
Tripsacum dactyloides L.
Panicum polyanthes Schult.
    sphaerocarpon Ell.
    linearifolium ?
    depauperatum Muhl.
    unciphyllum ?
Muhlenbergia capillaris Kunst.
Sporobolus heterolepis A. Gray.
Spartina cynosuroides (L.) Willd.
Eragrostis Frankii Meyer.
Eatonia obtusata (Michx.) A. Gray.
Melica mutica Walt.
Uniola latifolia Michx.
Panicularia elongata (Torr.) Kuntze.
Cyperus erythrorhizos Muhl.
    Lancastriensis Porter.
    strigosus compositus Britton.
Eleocharis Engelmanni Steud.
    palustris glaucescens (Willd.) A. Gray.
    Smallii Britton.
Scirpus fluviatilis (Torr.) A. Gray.
Rynchospora cymosa Ell.
Carex Frankii Kunth.
    squarrosa L.

  scabrata Schwein.
  aquatilis Wahl.
  costellata Britton.
  Caroliniana Schwein.
  pubescens Muhl.
  Jamesii Schwein.
  Shortiana Dewey.
Arisaema Dracontium (L.) Schott.
Eriocaulon septangulare With.
Commelina Virginica L.
  hirtella Vahl.
Pontederia cordata L.
Heteranthera reniformis R. & P.
Stenanthium robustum S. Watson.
Veratrum viride Aiton.
Allium tricoccum Aiton.
  cernuum Roth.
Erythronium albidum Nutt.
Vagnera stellata (L.) Morong.
Trillium grandiflorum (Michx.) Salisb.
Smilax pulverulenta Michx.
  hispida Muhl.
Iris verna L.
Galeorchis spectabilis (L.) Ryd.
Cypripedium acaule Aiton.
Blephariglottis peramoena (A. Gray) Ryd.
Leptorchis liliifolia (L.) Kuntze.
  Loeselii (L.) MacM.
Salix fluviatilis Nutt.
Juglans cinerea L.
Betula lenta L.
  lutea Michx.
  Allegheniensis Britton.
Castanea pumila (L.) Mill.
Quercus platanoides (Lam.) Sudw.
Celtis occidentalis L.
  crassifolia Lam.
  canina Raf.
  Georgiana Small.
Parietaria Pennsylvanica Muhl.
Rumex altissimus Wood.
Polygonum emersum (Michx.) Britton.
  incarnatum Ell.
  cilinode Michx.
Silene alba Muhl.
  Caroliniana Walt.
Holosteum umbellatum L.
Sagina apetala L.

Tissa rubra (L.) Britton.
Brasenia purpurea (Michx.) Casp.
Nymphaea Kalmiana (Michx.) Sims.
Magnolia tripetala L.
Ceratophyllum demersum L.
Asimina triloba (L.) Dunal.
Atragene Americana Sims.
Ranunculus Pennsylvanicus L. f.
Bicuculla cucullaria (L.) Millsp.
    Canadensis (Goldie) Millsp.
Adlumia fungosa (Aiton) Greene.
Cardamine hirsuta L.
    arenicola Britton.
    purpurascens (Torrey) Britton.
    rotundifolia Michx.
    flexuosa With.
Arabis laevigata Burkii Porter.
Erysimum cheiranthoides L.
Polanisia graveolens Raf.
Sedum ternatum Michx.
Heuchera roseola Rydberg.
    Curtissii T. & G.
Rubus Allegheniensis Porter.
    Baileyanus Britton.
    cuneifolius Pursh.
Prunus pumila L.
Crotalaria sagittalis L.
Meibomia sessilifolia (Torr.) Kuntze.
Lathyrus venosus Muhl.
Strophostyles helvola (L.) Britton.
Geranium Columbinum L.
Phyllanthus Carolinensis Walt.
Euphorbia commutata Engel.
Callitriche Austini Eng.
Ilex opaca Aiton.
Euonymus Americana L.
Acer spicatum Lam.
Sida hermaphrodita (L.) Rusby.
Hibiscus Moscheutos L.
    militaris Cav.
Ascyrum hypericoides L.
Hypericum Ascyron L.
    prolificum L.
    ellipticum Hook.
Viola villosa Walt.
    rotundifolia Michx.
Cubelium concolor (Forst) Raf.
Passiflora lutea L.

Opuntia opuntia (L.) Coulter.
Rotala ramosior (L.) Koehn.
Knieffia linearis (Michx.) Spach.
Aralia hispida Vent.
Hydrocotyle ranunculoides L. f.
Erigenia bulbosa (Michx.) Nutt.
Cicuta bulbifera L.
Oxypolis rigidus (L.) Britton.
Azalea arborescens Pursh.
Rhododendron maximum L.
Pieris Mariana (L.) B. & H.
Lysimachia vulgaris L.
Dodecatheon Meadia L.
Fraxinus Biltmoreana Beadle.
Chionanthus Virginica L.
Erythraea pulchella (Sw.) Fries.
Apocynum hypericifolium Aiton.
Gonolobus laevis Michx.
Vincetoxicum obliquum (Jacq.) Britton.
Ipomoea lacunosa L.
Cuscuta Polygonorum Engelm.
    Cephalanthi Engelm.
Phlox paniculata L.
    divaricata L.
Hydrophyllum Canadense L.
Macrocalyx Nyctelea (L.) Kuntze.
Phacelia dubia (L.) Small.
    Purshii Buckley.
Lippia lanceolata Michx.
Scutellaria serrata Andr.
    pilosa Michx.
Physostegia denticulata (Ait.) Britton.
Scrophularia leporella Bicknell.
Ilysanthes attenuata (Muhl.) Small.
Veronica scutellata L.
Gerardia Skinneriana Wood.
Melampyrum latifolium Muhl.
Utricularia gibba L.
Conopholis Americana (L. f.) Wallr.
Ruellia strepens L.
Dianthera Americana L.
Houstonia longifolia Gaert.
Galium concinnum T. & G.
Sambucus pubens Michx.
Viburnum rufotomentosum Small.
Valeriana pauciflora Michx.
Elephantopus Carolinianus Willd.
Eupatorium rotundifolium L.

hyssopifolium L.
Torreyanum Short.
coelestinum L.
Willugbaeya scandens L. Kuntze.
Solidago odora Ait.
Purshii Porter.
puberula Nutt.
Canadensis glabrata Porter.
juncea Aiton.
Boltonia asteroides (L.) L'Her.
Aster Pringlei Britton.
multiflorus (Ait.) Burgess.
Baccharis halmifolia L.
Polymnia uvedalia L.
Canadensis L.
Silphium trifoliatum L.
Verbesina alternifolia (L.) Britton.
Coreopsis tripteris L.
Arnica acaulis (Walt.) B. S. P.
Mesadenia reniformis (Muhl.) Raf.
Carduus altissimus L.
Lacinaria spicata (L.) Kuntze.

Volume 8 Number 3

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MARCH, 1905

A TRIP TO THE INAGUAS.

By George V. Nash,
New York Botanical Garden.

When I informed my friends that I contemplated making a journey to Inagua, they replied: "Yes, I know you will have an interesting time but—ah—where is Inagua?" Fearing that some of those who read this article may be as ignorant of the location of these islands as were my friends, and I too must confess to a dense ignorance concerning them and their location previous to my visit, I will rather carefully indicate their position and some of the features concerning them. To do this effectively, requires the presentation of the accompanying map.

The Inaguas comprise a group of two islands located at the extreme southerly end of the Bahamas, in about 21° N. lat. and 73° W. long., they lie, therefore 2° within the tropic, in the longitude of Long Island. The larger island is called Great Inagua and the other Little Inagua; it is the first of these that is more generally known and to which the name Inagua applies; the other island is seldom or never heard of by the outside world.

Great Inagua is about forty-seven miles long and at its broadest part is about twenty miles wide. The coast is irregular, especially on the northern side. Rocky shores are interspersed with sandy beaches. Along the north and south shores there are dangerous reefs, much feared by mariners who must navigate these waters. At other places the water is very deep quite up to the shore, so that large vessels can approach very close to the land.

Mathew Town, really the only town on the islands, is situated in the southwestern corner of Great Inagua. Here the Magistrate of the islands has his residence, dispensing justice to the inhabitants, most of whom are of the negro race—of a total of about two thousand people, only about twenty are whites. The town hall, accommodating, in addition to the court-house and post-office, the customs house and public library, is a square building not far from the sea. A rocky shore, with an occasional stretch of sandy beach, skirts the western edge of the town. There is no pier at which steamers can tie up to land passengers or freight, so that both must be landed in lighters or small boats. I had my first experience of this kind upon our arrival there at

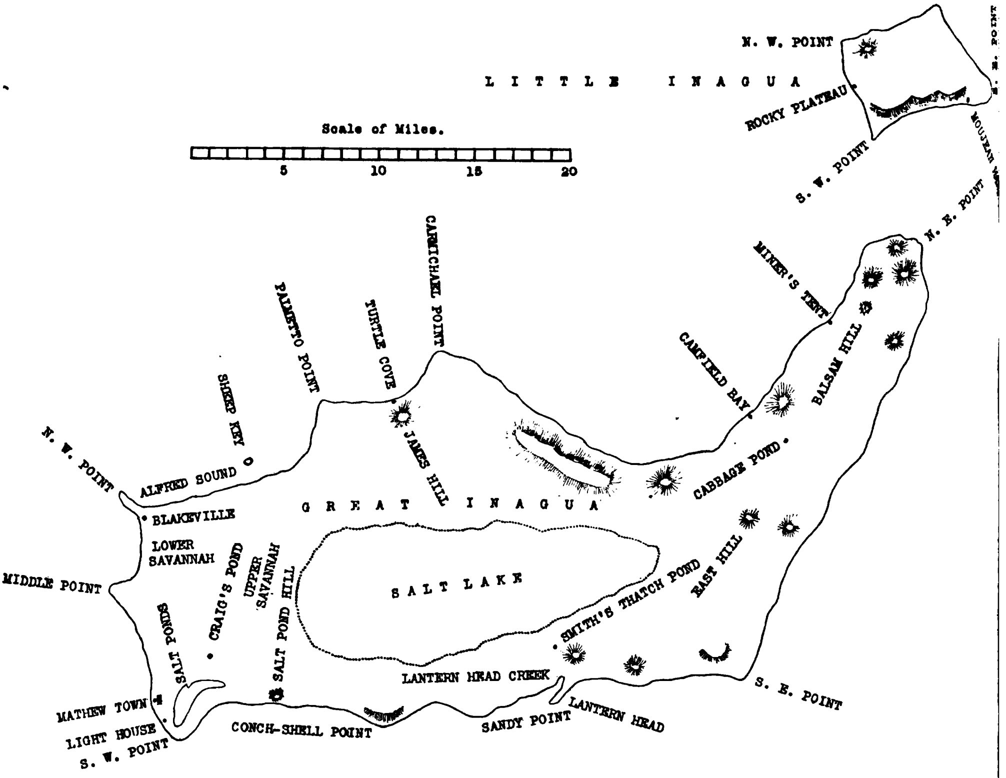

FIG. 16. Map of the Inagua Islands.

three in the morning on an October day. Additional excitement was added to this experience by a threatening thunder storm which broke shortly after we had reached the shore, and the rain came down only as it can in tropical countries. There is something decidedly fascinating to the uninitiated in this method of departing from a large steamer—the steamer by contrast is so light and the outer darkness so pitchy black. If the surf be running a little high, additional interest is given to the event when one approaches the shore and wonders, as a big comber rushes in from the inky blackness, whether he will reach terra firma in a dry or wet condition. But the big roller has been watched, and, the right moment selected by the careful boatman, and the big wave lifts up the boat and its human freight, depositing it far up on the beach. Woe be unto you, however, if he misjudges, and the wave breaks over the stern of the boat, forcing its bow into the sand and sweeping all before it. Then you wade ashore, wet, bedraggled and saying things about boatmen in general.

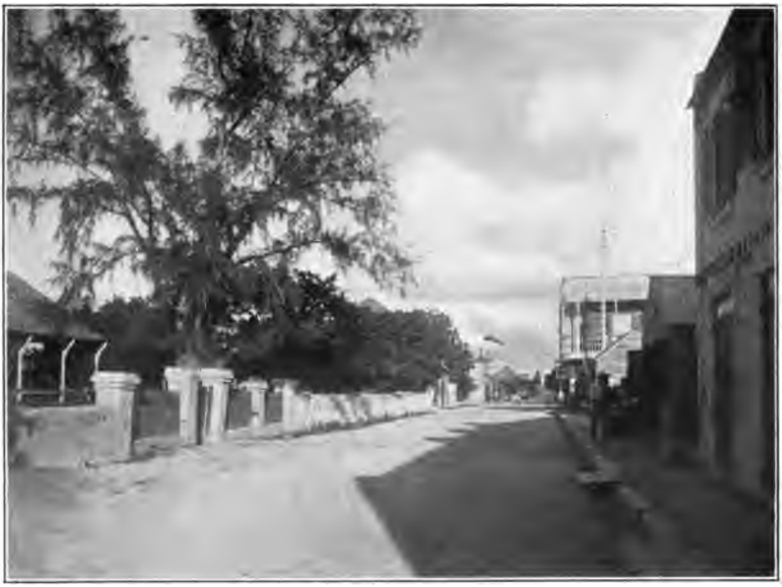

FIG. 17. View in Mathew Town. The large tree is *Casuarina equisetaefolia.*

A little over a mile to the south of Mathew Town is one of the best lighthouses in the Bahaman group. The light stands about 100 feet above the level of the ocean, and its first class minute-interval white flash can be seen many miles out at sea.

Little Inagua, lying about six miles to the north of N. E. Point, Great Inagua, is about eight miles long and five miles wide. It too has a rock-bound coast, in which sandy beaches are of frequent occurrence. There are no towns on this island, a few people living there spasmodically, as the humor takes them. The American Consul has a lease of the island, and has gone into the goat-raising industry there to quite an extent, claiming to have some fifteen hundred animals roaming through its wilds.

The surface of the country, on both islands, is essentially flat, being, with few exceptions, but a few feet above sea-level. This precludes any great variation in the flora due to altitudinal environment, and such floral formations as exist depend on other conditions. The islands are composed entirely of a limestone rock, porous and honey-combed with holes and caves, some of the latter of extensive proportions and reported to be filled with bat guano. The entrances to the caves occur at times in a mass of shrubs, so that in collecting it is necessary to be exceedingly careful, for a plunge into one of these openings would be a serious matter. They frequently descend fifteen or twenty feet perpendicularly, the walls and floor being furnished with jagged projections, so that a fall would result in severe cuts and bruises, if nothing worse happened.

Skirting the shores, and more rarely in the interior, are rocky ridges, often with slight elevations at irregular intervals. These elevations are really of little significance, and while appearing of considerable size as seen from the sea, on near approach seem to dwindle into almost nothing. I was often disappointed, on making a landing to climb one of these which seemed quite formidable from the sloop, to have it apparently melt into the general level. The dwarf character of the vegetation everywhere lends itself readily to this deception, the miniature trees and shrubs which abound on the islands making the hills appear from the distance larger than they in reality are. The highest point, East

Hill, is on the greater island, and has an elevation of one hundred and thirty-two feet.

The country rock, to which allusion has been made above, is but little disturbed on the lower portions of the land, but on the sides of the hills and at their summits it is often broken up into irregular masses, varying much in shape and size. These irregular masses abound with sharp points and jagged projections, making progress over them slow and tiresome. Many of these rock masses are tabular in shape and are nicely balanced on projecting points beneath. An incautious step on one of these might cause an ugly fall. These masses of rock resemble in brittleness and shape the large piles of slag which one often sees in the neighborhood of a blast furnace. Imagine an enormous pile of this, of a light grey color, with shrubs and small trees rising directly out of the chaotic mass, and you have a fair idea of the small hills of Inagua.

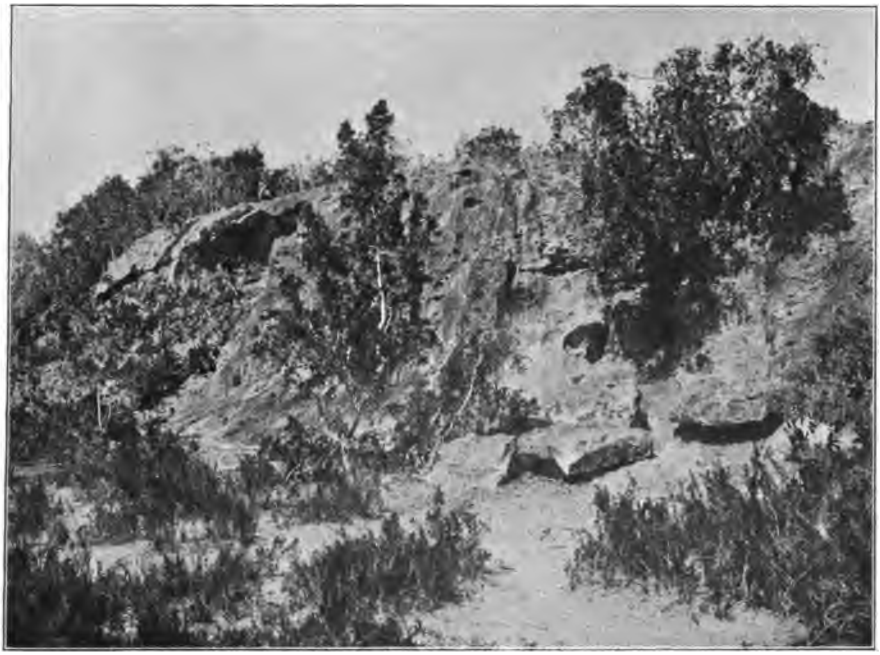

FIG. 18. Salt Pond Hill, where the salina formation impinges upon it, showing honey-combed character of the rock.

The climate is exceedingly dry for the greater part of the year, the rainy season lasting a few weeks only as a general thing. So free from rain is this region at times that for many years the production of salt by the evaporation of sea water was an extensive industry. This, however, in late years has dwindled to but a small part of its former greatness, and comparatively little salt is produced. Not that the island is any less suited to the industry, but neighboring islands with an equally favorable climate, and with the additional advantages of cable communications and better facilities for transporting the salt from the ponds to the shore, have made great inroads on the salt production of Great Inagua.

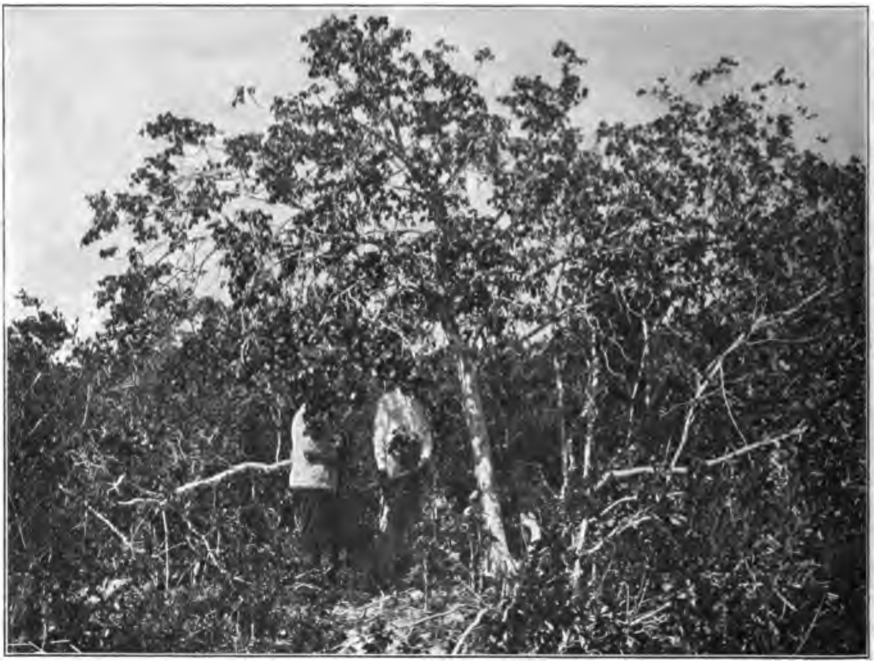

FIG. 19. View in the scrub.

With this description of the country and its climate the reader will be better able to appreciate the plant formations and the conditions with which the vegetation must cope. While a careful study of plant distribution could not be made in the short time spent by me on the islands, it was possible to gain sufficient information to warrant some conclusions. The vegetation may be divided roughly into five formations, enumerated as follows in the order of their importance: scrub, savannah, "white sand" ridges, salina, and strand. I will now attempt to briefly describe these, pointing out a few of the plants characteristic of each.

By far the largest formation is that of the scrub. This embraces not only the lower portions of the land but all the elevations. The surface is free of soil, the vegetation rising directly out of the rock crevices, or the herbaceous things, of which the number is remarkably small, finding a sustenance in the little soil which accumulates in the small pockets of the rocky surface. The vegetation of this region may be divided into the truly ligneous portion and the herbaceous or succulent. The former consists of

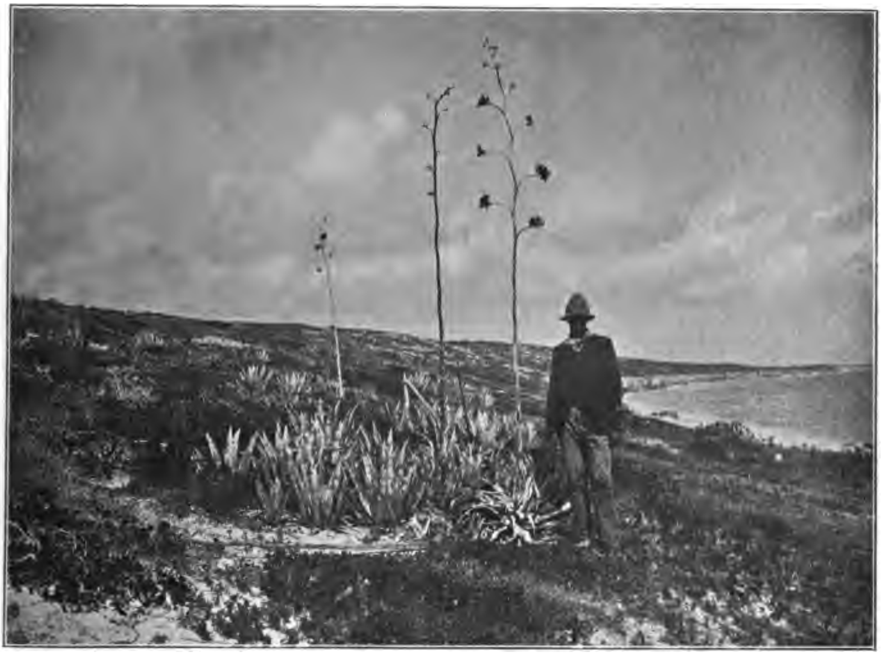

FIG. 20. South coast of Great Inagua, near Sandy Point, showing the depressing effect of wind on the vegetation.

trees and shrubs, sometimes so closely grown together that it is impossible to make a passage without constant resort to the machete. The general height of this vegetation is about six feet, in some portions perhaps rising slightly above this, with an occasional tree attaining to twelve or fifteen feet, these latter standing out like sentinels in the surrounding level sea of green foliage. The bark of nearly all of them is of a grey color, sometimes almost silvery. While some of the trees grow to the height mentioned above, most of them are dwarfs, four to six feet in height, symmetrical in outline, but with trunks rarely over a foot or two long—indeed they have all the appearance of the dwarfed tree produced by the Japanese. The leaves are all firm in texture, and give one the impression of great powers of resistance.

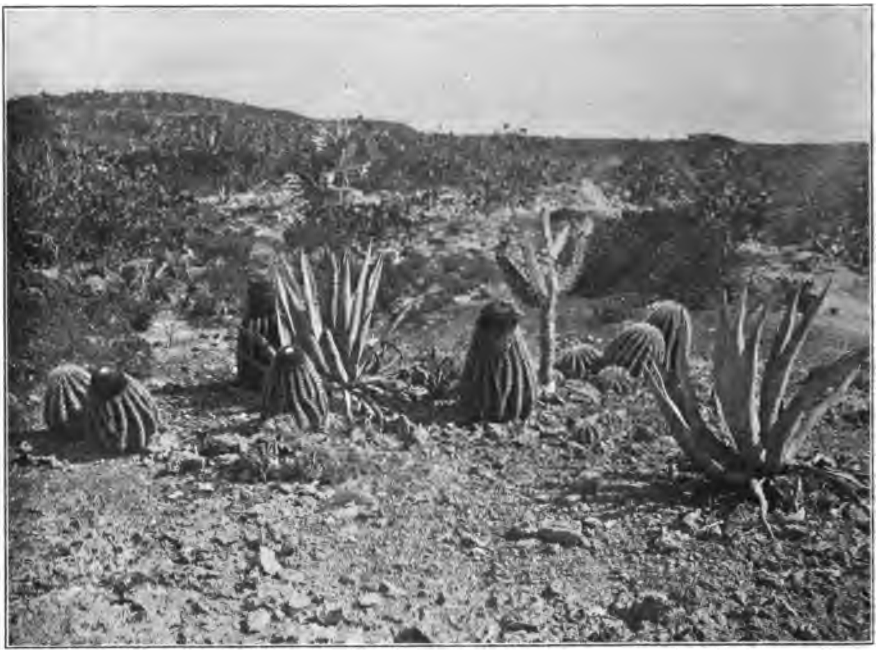

FIG. 21. Cactus formation at Moujean Harbor, Little Inagua. *Melocactus* and *Opuntia* in the foreground, with the *Agave* common there.

While the general appearance of the scrub is that described above, there is a region on the south coast which bears but little superficial resemblance to this. I refer to the southern slope of the ridges which run right down into the sea. All during the summer months the southeast trade winds blow, with almost hurricane violence at times, creating a sea which dashes far up on the rock-bound shore, leaving large boulders in endless confusion as evidence of its fury. This wind has a decided effect on the vegetation, as is evidenced by the depression of all growth. No difference is noted in the composition of the flora, for the same shrubs occur here as elsewhere; their growth is however lateral, and they often cover a hundred square feet or more. Seldom do they rise above a foot in height, and this depression gives to these regions along the south coast a most dreary and inhospitable aspect, even in bright sunny weather—in stormy weather it must be depressing in the extreme.

(*Note.* Figures 16 and 18–21 inclusive are reproduced by the courtesy of the New York Botanical Garden.)

(*To be continued.*)

ON THE NOMENCLATURE OF FUNGI HAVING MANY FRUIT-FORMS.*

By J. C. Arthur,
Professor of Botany, Purdue University.

In the commemorative volume of essays presented to Professor Dr. Ascherson of the University of Berlin, upon the seventieth anniversary of his birthday by his pupils and admirers Dr. P. Magnus† has made a strong and notable plea for conservative methods in selecting the name to be used for species of fungi which, possessing dissimilar forms of fruit, have in consequence been fractionally assigned to two or more genera. The problem to which attention is directed may be very clearly set forth by an illustration so well known that the situation will be readily grasped even by those who have little knowledge of the fungi and no interest in the settlement of the difficulty.

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* Read before the Indiana Academy of Science, Indianapolis, Ind., Nov. 25, 1904.

† Magnus, P. Einige Fragen betreffend die Nomenclature der Pilze mit mehreren Fruchtformen. Festschrift zu P. Ascherson's 70 Geburtstage: 431–438.

In 1793 Jacquin, an Austrian botanist, described a curious and microscopically beautiful fungus, which he found growing in the tissues of the barberry leaf, and named it *Lycoperdon poculiforme.* This fungus produces numerous cup-shaped receptacles about one millimeter across, ten to twenty in a place, clustered upon a cushion-shaped thickening of the leaf, and filled with round, orange-yellow spores in chains. This fungus was shortly afterward transferred to the genus *Aecidium,* and is known in English as the barberry cluster-cup fungus.

In 1789 Schrank, a Bavarian botanist, described a fungus parasitic in the culms and leaves of various grasses and producing rust-like streaks of spores a centimeter or more long, which he called *Lycoperdon lineare.* The spores are not inclosed in a receptable, but each is borne on a pedicel, from which it easily separates, is brownish yellow, oblong in shape, covered with fine sharp points, and has four pores placed equi-distant about the equator, through which the germinating tubes may pass. This fungus was subsequently placed in the genus *Uredo,* and is known in English as the stem rust of grain.

In 1794 Persoon of Paris described and named *Puccinia graminis,* also parasitic in the culms and leaves of various grasses, and forming black or blackish, erumpent masses, one or two millimeters broad. The spores of this fungus are many times as large as of the others, and have a smooth, resistant, blackish brown wall. They stand compactly side by side, each consisting of two cells, which may germinate independently. Instead of falling away readily, as in the other two cases, they remain where formed, and only germinate after a long period of rest, usually over winter. In Great Britain this fungus is called mildew, and in America the black grain rust.

Three more diverse forms can scarcely be found among microscopic fungi, and this assignment to independent genera by the early mycologists was clearly justifiable. Even in those days, however, there were keenly observant persons, who fancied some connection existed between them, different as they are. In 1865 it was proven beyond all doubt by deBary that these three fungous forms, that had received independent names, and for three quarters of a century been accepted as members of diverse genera were truly one organism in its three stages of development, exhibiting a series of transformations the like of which is only known among insects, such as the butterfly, which makes a cycle of pupa, caterpillar, and winged imago. The proof consisted in sowing one kind of spore and securing a crop of one of the other kinds, from which in turn the third was obtained.

It is a curious commentary upon the progress of systematic botany as applied to this class of plants, that nearly four decades have passed since deBary's demonstration without an agreement being reached regarding the correct name of the fungus. It is very generally called *Puccinia graminis,* and the three forms are designated as aecidium, uredo- and teleutospore stages. Some botanists, however, believe that the laws of botanical nomenclature as set forth in the Paris code, or the later modifications of the same, which are now recognized as more or less completely binding upon students of the higher plants, should also apply to the fungi, and to those with diverse fruit-forms as well as to those having a single fruit-form. This would require that the oldest specific name be used, and the fungus would become *Puccinia poculiformis,* as in fact, the more radical mycologists have for some years insisted upon writing it.

From what I have said it will be seen, I think, that the question at issue relates to the choosing of a name from a number of synonyms. The question is more important than appears at first sight, for it not only means that the solution will remove confusion, but that the concepts on which it is based will be affected, with a corresponding reaction upon the development of the science. I will first quote Dr. Magnus. "Although Jacquin had named the *Aecidium* upon *Berberis vulgaris* as *Lycoperdon poculiforme,*" he says, giving his words an English form, "and had described it in his *Collectanea,* and deBary in 1865 had proved that the *Aecidium* on *Berberis vulgaris* belonged to *Puccinia graminis* Pers., yet it is incorrect, in my opinion, to designate this

Puccinia as *Puccinia poculiformis* (Jacq.), as Wettstein has done. For that would imply that Jacquin under his *Lycoperdon poculiforme* had meant the *Puccinia graminis* Pers., and that Wettstein having in fact recognized this, had only transferred a circumscribed and definite species into another genus. This is, however," continues Dr. Magnus, "altogether false. Jacquin had really no idea of the *Puccinia graminis* Pers., which Persoon had first comprehended and described. Now as the characters of the genus, to which this fungus belongs, and also the specific characters in large part, are directly derived from the teleutosporic form, the fungus should, therefore, retain the first name given to this characteristic teleutosporic form, which in this case is *Puccinia graminis* Pers." Dr. Magnus proceeds to give other examples of what he considers the wrong and the right way of applying names to polymorphous fungi, but what I have taken will answer sufficiently well for a text. The same ideas have recently been expressed in quite similar language by Professor P. A. Saccardo,* in stating his rules for guidance in describing and naming fungi, and some years ago were presented in a more extended form by Dr. W. G. Farlow† in his comments on the third and eleventh centuries of Ellis' exsiccati.

There is no difference of opinion among the parties to this controversy regarding the desirability of using the oldest specific name for all fungi, and other plants as well, providing the name selected has been properly established. But is a name given to a secondary form of the fungus worthy of recognition under the law of priority; that is the question. Leaving aside the matter of expediency, it seems to me that the answer depends upon what is implied by a name.

When a name is given to a new plant, does that name apply to all parts of the plant, even if the author of the name does not specifically mention certain of them, of which in fact he may have no knowledge; and does it cover the plant in all its forms, even such as the author did not know existed; or must the name be restricted to such parts of the plant as the author had in hand, or which he covered by his description. Let us illustrate: suppose a botanist in his travels should come across a rare tree with very characteristic foliage, but no flowers or fruit, and should name and describe it. Subsequently, another botanist finds a tree with most peculiar fruit but at a season of the year when foliage is absent, and this he describes and names. After a time it is ascertained that the two names have been applied to the same species of plant. Now must the plant receive a new name, as neither of those already applied adequately described the plant, or in case one of them is selected can it be held that the other is not an admissible name because it did not cover a sufficiently important part of the plant?

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* Ann. Myc. **2**: 195–8; English translation in Jour. Myc. **10**: 109–112. 1904.

† Proc. Amer. Acad. Sci. **18**: 66–69. 1883.

Let us illustrate in another way: Michaux named a much-branched, spreading, rough plant, with solitary, inconspicuous flowers, *Lithospermum angustifolium.* Pursh subsequently named a soft-leaved plant with simple, upright stems and clusters of showy flowers twenty-five to thirty-five millimeters long, *Batschia longiflora.* Although the two plants were exceedingly unlike, it finally became known that the latter was the perfect, spring form, and the other the cleistogamous, summer form of the same species of plant. Now is the earlier name ineligible because applied to an imperfect state of the plant? Saccardo* says that "when the name of an earlier stage of any species is found to have been published before the name of the correlated perfect stage, it is not permissible to transfer the name of the imperfect stage to the perfect one upon the plea of priority." But phanerogamic botanists do not follow such a rule, and the earlier specific name in the case just cited is now used, although Michaux knew nothing of the perfect stage when he bestowed it.

In proceeding to strengthen his position Magnus states that the characters of the genus *Puccinia* are derived from the teleutosporic stage, and that specific names should only be employed which were first applied to this stage. But in some other genera he finds that the teleutosporic stage is relatively far less prominent, as in *Uredinopsis,* and here he would permit the use of specific names first used for the imperfect stage. Thus *Septoria mirabilis* is the name given years ago to a common fern rust by Peck, and at the time he did not recognize the fungus as a member of the *Uredineae*, or in anywise related to the true rusts. Not long since the teleutospores were discovered, inconspicuously buried in the tissues of the host. Dr. Magnus maintains that the specific name of the imperfect stage is eligible under the law of priority, because it was applied to the more conspicuous stage and the two stages are usually found associated in the same host plant. This is a method of selecting the specific name, however, distinctly prohibited by Saccardo's rules, as the portion cited above clearly shows.

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*Rule X, l. c.

(*To be concluded.*)

A TREASURE SPOT OF WILD FLOWERS.

By S. G. Streeter,

High School, Trenton, N. J.

There are still to be found places in New England where wild flowers have been able to hold their own. Back among the foothills of the Green Mountains on a hillside sloping sharply to the east, terraced by broken rocks and jagged ledges there is such a bit of woods, not more than twenty acres in all, where the number and variety of native plants are a constant source of surprise and delight.

The oldest inhabitant cannot remember that the ground was ever cleared. Most of the trees are maples, growing straight and bare for twenty or thirty feet up to the first branches. Scattered among them are a few beeches, iron woods, hemlocks, ash trees, and birches. Ferns grow in great abundance and here may be found varieties of lady-fern, great beds of maiden hair, clumps of marginal Shield-ferns, Christmas ferns scattered everywhere, common polypody draping the rocks, the ebony spleenwort half hidden in the clefts of the ledges, New York ferns filling in all the spaces nothing else wants and on the flat down at the bottom are to be found growing in great profusion, the rattlesnake and sensitive ferns.

But ferns are not the only flowerless plants to be found. Fungi and lichens are always plentiful. On the dry hill-tops there are three varieties of club mosses growing and the shaded rocks are carpeted with many species of true mosses.

The flowers begin to open before the snow drifts have gone and last until the frosts have taken the last aster and stalk of goldenrod. The first to appear are the hepaticas growing high up on the sunny side of the rocks. A little later there are the graceful dicentras hanging on shelves in the ledges, so high up that they have been many times declared " sour grapes " by an envious passer-by. At any season this ledge is the gem of the woods. Around it can be found the little yellow violet, the first spring beauty, the adder's tongue, mitrewort, Jack-in-the-Pulpit, wild garlic, blue cohosh, purple trillium, red and white baneberries, Canada violets in bloom nearly all the summer, downy violets, and the common blue violet (present in one or more of its many forms). There is a clump of showy orchids which adds one or two to its number each season and a few stalks of purple or white fringed orchids can be found every year. Woodbine and wild ginger cover the broken rocks at the base of the ledge.

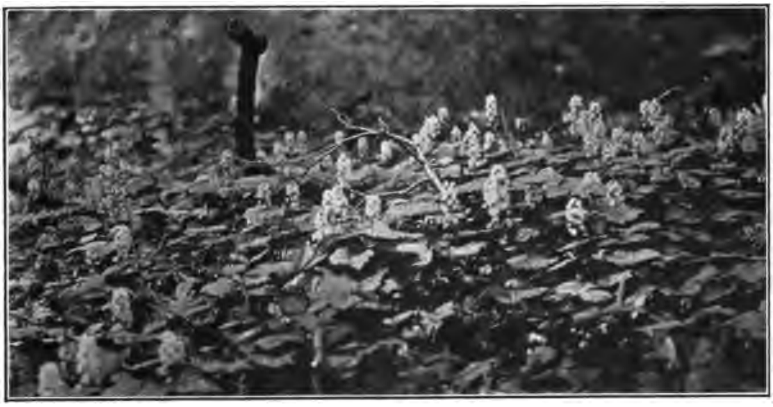

FIG. 22. A bed of Foam Flower, *Tiarella cordifolia.*

Going on up the hill there are beds of feathery foam flower nooks filled with two-leaved Solomon's seal, and old stumps hidden in black night-shade. One may happen upon a bunch of Indian pipes, or a solitary plant of beech-drops or a few stalks of one-flowered cancer-root. Herb Robert clings to the rocks and blooms all summer long. In their seasons shin-leaf, water-leaf, wood and field strawberries and the partridge vine abound. The more exposed slopes are covered with speedwell. Near the top of the hill is a space filled with bellwort, Indian cucumber-root, wild sarsaparilla and Solomon's seal.

This old hillside is truly an ideal spot to the nature lover. If only it might be left unmolested, but already the roof of the first summer house has appeared in the distant landscape and rumors of invading trolley lines are abroad. The few people who know this Eden are awaiting with fear the day when egg shells and paper bags will litter the moss, and the fern fronds will lie fading beside the track of the trolleys.

THE BIOLOGY OF BUDS AND TWIGS IN WINTER.*

By Dr. K. M. Wiegand.

Some of the important facts in connection with the life of winter buds in our climate are very poorly understood. Measurements tend to show that fruit buds, at least, do not swell during the winter, but only in late spring. It seems that the color of buds may influence the absorption of heat to some extent, and therefore may be of importance in influencing the time of opening in the spring.

Ice is present in most buds if the temperature falls below about 24° F. At zero F. the amount is often very large, and of thirty species examined only in eight could none be found. The ice forms in large sheets of prismatic crystals in the mesophyll of the scales, and in the parenchyma of the various other organs. The cells give up their water and collapse, while many of them are forced far apart by the ice. Twigs show a decided contraction on freezing, due to the expulsion of air from the intercellular spaces. The contraction of buds is not marked. Buds thaw out in inverse ratio to the freezing, so that ice will not usually be found after the temperature has risen to 27° F.

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* Abstract of a paper read before the Botanical Society of America, Dec., 1904.

Regarding the function of bud scales it may be said that no evidence exists to show that scales are for the purpose of keeping out external moisture. Neither are they for the purpose of modifying temperature as is popularly believed. Experiments showed that in some cases at least, scaly buds may warm up even faster than would be the case if the scales were not present. Wool and hair in the bud are for the purpose of preventing rapid transpiration from young shoots when they first emerge. For the same purpose, the scales in many trees grow out into a tube at vernation. But scales are mainly important to the bud in preventing drying out due to the escape of water by evaporation, and in preventing mechanical injury from contact with surrounding objects.

THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

Announcement by the Secretary.

A part of the income of the Stokes Fund for 1905 for the Preservation of Native Plants has been devoted to the printing and distribution of a poster which reads as follows:

WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

NOTICE.

The Gathering of Wild Flowers and Ferns and the Cutting or Injuring of Any Tree or Shrub, or the Starting of Fires on these Premises is strictly Forbidden Under Penalty of the Law.

This poster measures 10 by 12 inches, is printed on muslin, and may be had on application by any member of the Society from the Secretary of the W. F. P. S. A., Elizabeth G. Britton, New York Botanical Garden, Bronx Park, N. Y. City.

The remainder of the appropriation for the year will be disbursed in the form of a number of prizes for short essays indicating local needs. These essays will be published as leaflets and will be distributed to members for circulation.

EDITORIAL.

This month we are publishing the first half of an instructive contribution to the discussion of nomenclature of plants. There is we think some misapprehension in the minds of many in regard to the nature of the problem which often confronts the student of taxonomy—it seems to be a mere matter of words, with no real issue. Professor Arthur shows very clearly what the issue is in the nomenclature of parasitic plants which appear in various forms in different hosts, and we believe that those who read it will find instruction in his discussion.

THE " TREASURE SPOT " of vegetation described elsewhere in this issue by Miss Streeter is an example of many such. These, often small areas are fit subjects for the thought of the Wild Flower Preservation Society. Why may it not be possible to educate public sentiment to the end that small towns and villages shall take an interest in the preservation of areas within their influence which may be saved in their natural condition for the pleasure and education of people. Many preserves might thus be set aside at a small cost to the public. There would then spring up a system of small and large country parks throughout the land where the native plants peculiar to various localities would find a natural home for ever.

SINCE THE APPEARANCE of The Origin of Species in 1859 no one book, it may be safely asserted, will in the future be found to have influenced modern thought and activity in the study of evolution as that which embodies the labors of the eminent Dutch botanist, Hugo deVries, and which was published under the title Die Mutationstheorie. Within the last few weeks a second book, Species and Varieties: their origin by Mutation, being a less technical and detailed treatment of the problems discussed in the earlier work, has been given by deVries to the English speaking peoples in their own language. This volume replete with suggestion and inspiration well deserves the full account of it which we have planned to give to our readers.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

BOTANICAL GEOGRAPHY FOR SCHOOLS.—In the *Geographical Teacher* (**2**: 201. 1904) C. E. Moss urges the teaching of " Botanical Geography " in secondary schools. As hints for the kind of facts to be noted and studied, the author refers to the fact that the temperature, moisture and soil of a given area give rise to a type of vegetation *dominant* for that area. " Associated with the dominant species are less abundant but plentiful plants forming the *sub-dominant* species. Other species, dependent on the foregoing for protection, food, or support are *dependent* species. Such communities are plant associations or plant formations." The whole habitable surface of the globe may be regarded as being occupied by various plant associations.

Almost every school district furnishes examples of a few such plant associations, and those districts which include hills, marshes, or the sea coast furnish a great many. The following are the chief British plant associations that have been described:

1. Alpine: moss and lichen covered crags and Alpine heaths and pasture at 2,000 feet and upwards.
2. Sub-Alpine: Cotton-grass, bog-moss, etc., at 1,250–2,000 feet.
3. Woodland: Birch, pine, oak, ash, and beech woods.
4. Lowland alluvial: Aquatic and sub-aquatic associations of ponds, bogs, and swamps.
5. Maritime: Found on dunes, dune hollows, mudflats, and rocky headlands.

6. Region of cultivation.

It is recommended that *one* type of vegetation be made the subject of special study, and the facts of distribution plotted on government contour maps. Thus, " The pupils are trained in the use of ordnance maps—itself a most valuable discipline. . . . The use of a pocket compass, and perhaps also of a pocket aneroid is also seen. The value of contour lines, of scales, and of map symbols is realized. The relation between the vegetation and the landscape . . . is made clear by the personal observations of the pupils; and the formation of accurate concepts of the vegetation and the landscapes of foreign countries. The regions of the locality and of Greenland have been recognized by the pupils, the teacher is in the possession of a powerful means of enabling his pupils to grasp the significance of the vegetation regions of the world."

The appeal to enlightened teachers in English schools to put this method to the test may also be strongly made to teachers in our own country. C. S. G.

The use of the expression plant " formation," in the note above, suggests again what a poor term this is. Attention has already been called to this fact by Knowlton. (*Science* II, **19**: 467. 1904.) The term has been for so long a time applied in an entirely different sense that it should be wholly dropped as a synonym for plant "association." C. S. G.

WINTER SHOOTS OF A SPECIES OF CHICKWEED.—The resting buds of water plants known as " hibernaculae " are well known to every one who has collected any of these plants in the late autumn. The term hibernaculum is applied to a winter bud of a submerged water plant, one which arises from the shortening, or rather the failure to lengthen of the internodes at the end of a shoot. This causes the crowding of the leaves into a dense round or oval green mass. Hibernacula are very noticeable in such forms as have an otherwise loose habit of growth, such as occur in species of *Utricularia*. What appears to be an analogous condition in a land plant, *Stellaria nemorum*, a native of Europe, has been described.*

This plant grows on the damp, mossy rocks of the narrow ravines so characteristic of the region of Eisenach in North Germany. It has been noticed by Neger that many of the normal plants arose from horizontal runners, which differed from the upright shoots in their long internodes and minute leaves, and although these runners had not previously been noticed the occurrence did not surprise him because it was known that such a condition might readily be produced by extreme dampness or reduced light. In winter however all the plants lie parallel to the ground, but on account of the steepness of the surface, they hang downwards toward the bottom of the ravine. The stems attain a very considerable length, as much as 1–2 meters, some of the internodes having a length of 6–10 cm. Moreover the ends of these hanging shoots, instead of swinging freely, penetrate into the mossy turf or loose soil, a unique behavior in such plants.

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* Neger, F. W. Flora, **93**: 160. 6 Feb., 1904.

The terminal shoots do not however become entirely buried or even partly so in all cases, but take on the hibernacular character while lying on the sub-stratum.

This habit is accounted for in part by the fact that these winter shoots fail to respond to the geotropic and phototropic stimuli, but do so to the presence of water. Being chiefly hydrotropic they enter the substratum. Here the internodes are short, the leaves are small and more fleshy than the normal, and when hidden from the light, do not become green. Being thus buried they are protected from the cold of winter. Taking root they are ready on the advent of spring to send out new shoots which are vertical in their growth. These curious shoots are then quite comparable with the hibernacula of water plants. It is well also to note that some if not all of our northern species of *Lycopodium* behave similarly. Thus *Lycopodium alopecuroides* on the approach of the limit of growth, sends the tip of its stem into the ground or moss in which it grows, and this tip, a thickened, starch-supplied portion is all which lives till the next season. F. E. L.

MOVEMENT OF THE BRANCHES IN SHRUBS AND TREES.—Some hitherto undescribed facts have recently come to light regarding the phenomenon of movement of the branches in shrubs and trees.* Observations and measurements made by Professor W.

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* Ganong, W. F., An Undescribed Thermometric Movement of the Branches in Shrubs and Trees. Ann. Bot. 18. Oct. 1904.

F. Ganong, on the willow, mountain ash, paper mulberry, flowering dogwood, spice bush, etc., show that in winter the ascending branches have a tendency to move inward, nearer and nearer to the main stem, while on the approach of spring, these same branches move outward, separating more and more from the main stem. A branch of the willow, *Salix laurifolia,* for example, moved inward 12.7 cm. or about five inches, between October, when the leaves were all on, and January, when the tree was in full winter condition. From January to June the branches moved gradually outward 44.5 cm., or nearly eighteen inches.

The seasonal movements accompanying leaf fall and leaf formation are obviously due to the removal of the weight of the leaves in the one case, and the addition of weight in the other. The further continued movements during each season, irrespective of the leaves, Professor Ganong found to be correlated with changes in temperature, a higher temperature resulting in an outward, and a lower temperature in an inward movement, these secondary movements having been observed, also, within a single day and night.

The explanation offered for this movement of the branches is as follows. With a fall in temperature the amount of water gained by osmosis is below that lost by transpiration; the cells become flaccid, and an inward movement of the twigs results, the inward position being the natural one for dry tissues. On the other hand, with a rise in temperature, absorption exceeds transpiration; there is an increase of turgidity in the cells, and a consequent swelling, straightening, and outward movement of the twigs. In brief, the movement is connected with the amount of water in the stem, the amount of water being dependent upon temperature, and the seasonal movement is simply a temperature movement on a larger scale. M. M. B.

MOSSES, TREES AND POINTS OF THE COMPASS.—A recent number of *Ciel et Terre* (December 16, 1904) contains a note on the orientation of moss growths on trees. It has been stated that mosses grow so much more frequently on the north sides of trees that a traveler who has lost his way in a forest can by this means determine the points of the compass. Lately, further investigation of this matter shows that the mosses grow by preference on the sides of the trees which, for one reason or another, are least likely to lose their moisture. On horizontal branches, the mosses usually grow on the upper side, because the water remains there most readily. The bases of the trunks are more moss-covered because they receive a larger quantity of water. The unequal distribution of light also plays a part.—(Science, 17 Feb., 1905.)

STIPULES IN THE CULTIVATED RUBBER PLANT.—All who have grown the ordinary rubber plant are familiar with the white or red membranous hood which clothes the terminal bud. That this is made up of two connate stipules is evidenced by the occasional appearance at the tip of the hood of two points, the apices of the two elements. This hood, the insertion of which extends quite around the stem, persists until the unfolding of the blade of the leaf next above in position. In the young shoots which are forced to grow by cutting back the stipules, which of course enclose the terminal bud, are for some time quite distinct, each member of a pair being slender and not at all connate with its mate, a condition which may be regarded as nepionic—that is, probably represents the primitive stipular condition in the plant in question. As the new shoots continue to develop the stipules later produced are connate, and so conform to the mature type.

Cardamine chenopodiifolia IS A South American species which produces hypogaeous flowers and fruits, as well as those of the ordinary type. This dimorphism is explained by O. E. Schultz* as an adaptation of the plant, not to the unfavorable climatic conditions, as was held by Griesebach, but as a means of propagation which, by position, protects the plant from the danger of eradication by grazing animals.

THE MATERIAL WHICH is usually lacking from the supply of forms for laboratory work is that representing the families of plants whose flowers appear earliest in the year. Now is the time to lay in a supply which may be preserved for future use. For small and delicate flowers strong alcohol is best and they should not be crowded in too tightly. For others which are not easily damaged, such as willow, etc., a three per cent. solution of commercial formaldehyd may be used. A solution of formaldehyd (1 per cent.) and chrome alum (1 per cent.) in water is recommended because it does not make the tissues brittle.

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* Monographie der Gattung Cardamine. Botan. Jahrb. 4:32. 1903.

REVIEWS.

Species and Varieties: Their Origin by Mutation.*

I

If all the plants and animals now living and that have ever existed in the past could be assembled in one place, it would be possible to arrange them in such a way as to show their relationship to each other. This is the doctrine of descent, and is part of the broader theory of evolution. The general acceptance of organic evolution dates from the appearance of the Origin of Species in 1859.

The process of natural selection was elaborated by Darwin and in less detail by Wallace as the method of the origin of species. Thus arises a demand for materials upon which natural selection may act. This demand is supplied by variation.

Two kinds of variations are now recognized. Those resulting from the influence of environment, direct or indirect, are termed *individual.* Since all degrees of intermediate grades are recognized between the extremes of departure and the norm, this is sometimes called *continuous,* and since the degree of variation is not fixed, but may oscillate about a mean between two extremes, the term *fluctuating variation* is also employed. Continuous or fluctuating variation always means an increase or decrease of some quality or character already existing. It is a case of more or less. A fruit may grow sweeter, a flower larger, a root fleshier, but nothing really new results.

There is also recognized another kind of variation which proceeds by the introduction of entirely new characters. Structural features not present before result, and what is more important yet, the change is abrupt and permanent. There has been a sudden and complete change. Transitional forms are wanting. This is *discontinuous variation.*

Which kind of variations furnish the material for natural selection to act upon? Do both kinds or does only one? For Darwin and his followers it was mainly the fluctuations. The serious difficulties in the way of accepting this idea have never been successfully met. According to the theory, natural selection is a case of life and death. The struggle is between the fit and the unfit, and only the useful survives. But how can incipient new characters and their earlier intermediate grades be of use? Complete reduction of leaf surface, for example, is obviously a useful character in the adaptation of plants to withstand a desert climate, but in what way small, almost inappreciable, amounts in such reduction of surface could serve the plant in its struggle against drought and enable it to persist is impossible to conceive.

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*Species and Varieties: Their Origin by Mutation. Hugo deVries, edited by D. T. MacDougal. Chicago: The Open Court Pub. Co. 1905.

Again there are no transitional forms between the different species of plants. Those who seek "connecting links" do not adequately comprehend the problem. But whereas species are discontinuous, environment is continuous. If fluctuations, a function of environment, had furnished the material for natural selection, then species ought to be continuous. Gradations, or "connecting links," would be abundant.

The enormous length of time required to bring about the present condition by the selection of individual variations is another obstacle to their acceptance as the materials of natural selection.

Darwin was less blind to these difficulties than some of his ardent followers have been, and in the latter editions of the *Origin* recognized that he had too greatly neglected discontinuous ("spontaneous," as he called it) variation.

The importance of correct views as to the material upon which natural selection works is paramount for, as Bateson* has well said, "Variation . . . *is* evolution," while natural selection acts as a directing and conserving force.

The all importance of discontinuous variation as at least one method of the evolution of plants is emphasized and elaborated under the term *Mutation* by deVries in *Die Mutationstheorie* (Vol. I, 1901, Vol. II, 1903). Most of the objections to the natural selection of individual variations as the manner of origin of species can not be urged against the mutation theory. Most important of all for science this theory is capable of experimental demonstration. One of the weighty objections to "Darwinism" was that no one had ever seen a new species arise and never could do so. This deVries has done and the experiment may be repeated by any one at any time with the requisite care and skill. His "work claims to be in full accord with the principles laid down by Darwin, and to give a thorough and sharp analysis of some of the ideas of variability, inheritance, selection and mutation, which were necessarily vague at his time." †

The present volume comprises the lectures delivered by the author at the University of California during the summer of 1904. It is not a translation or abridgment of the *Mutationstheorie,* but quite a new volume, and the author has "tried to devote attention to the more important phases of the subject," and has "avoided the details of lesser interest to the general reader." The editor, Dr. D. T. MacDougal, of the New York Botanical Garden, is undoubtedly the best qualified for the task of any one in this country, having repeated deVries' experiments, confirmed his results and added new and valuable contributions to this important phase of the experimental study of evolution.

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* Bateson, Materials for the Study of Variation, p. 6. New York, 1904.

† deVries, Species and Varieties, p. ix.

The introductory chapter reviews the various theories of evolution and methods of investigation. The theory of descent and of natural selection are discussed, and the true function of natural selection emphasized by the use of the striking figure of the sieve. Natural selection "is the sifting out of all organisms of minor worth through the struggle for life. It is only a sieve, and not a force of nature, no direct cause of improvement, as many of Darwin's adversaries, and unfortunately many of his followers also, have so often asserted. It is only a sieve, which decides which is to live, and what is to die. But evolutionary lines are of great length, and the evolution of a flower or of an insectivorous plant is a way with many side paths. It is the sieve that keeps evolution on the main line, killing all, or nearly all, that try to go in other directions. By this means natural selection is the one directing cause of the broad lines of evolution.

"Of course with the single steps of evolution it has nothing to do. Only after the step has been taken, the sieve acts, eliminating the unfit. The problem as to how the individual steps are brought about, is quite another side of the question."

As to this last point two methods are conceivable: (1) fluctuations, and (2) mutations. Of these Darwin recognized both, Wallace only the first. At present there are two camps of evolutionists, the Neo-Lamarckians, who hold that organisms may be changed by the direct influence of environment, and the Darwinians, who "assume fluctuating variations in all directions and leave the choice between them to the sieve of natural selection."

DeVries elaborates his theory first "by a critical survey of the facts of agricultural and horticultural breeding," "combined with some corresponding experiments concerning the real nature of species in the real state"; second, by his own observations and experiments at Amsterdam.

After describing the methods of scientific pedigree culture, the distinction between species and "elementary species" is carefully drawn. Species "are the practical units of the systematists and florists, and . . . are not really existing entities." They may be broken up into varieties and sub-species. The real units are the elementary species; ". . . any form which remains constant and distinct from its allies in the garden is to be considered as an elementary species" (p. 12). Elementary species are exactly what Linnaeus designated as varieties.

Elementary species must not be confused with *retrograde varieties*. The latter result from the loss of some special character, while the former have originated in a progressive way and attained something entirely new. Thus orchids have originated by progressive development, hundreds of steps being required.

Retrogression is as much evolution as is progression. Monocotyledons have evolved from primitive dicotyles by the loss of characters. The investigator in experimental evolution deals with the single steps, and must sharply distinguish between progression and retrogression, for progressive steps mark an elementary species. This process is ***mutation,*** and the product a ***mutant*** (elementary species).*

Mutants make a clear departure from their ancestors. They are not connected with them by gradations, and do not revert to the parent type. Fluctuating variations "always oscillate around an average, and if removed from this for some time they show a tendency to return to it" (p. 18). This tendency is retrogression.

Mutants, as well as fluctuations, furnish the material for both natural and artificial selection to work upon. There is both an inter-specific and an intra-specific, or individual struggle. The battle between the individuals of a species leaves a hardier or "fitter" species, that between species allows only the hardiest or fittest species to survive. Thus Spencer's expression, "survival of the fittest," as Morgan has pointed out, is incomplete and should read, "survival of the fittest species."

Not all plants are now in a state of mutation, but for experimentation it is necessary to find a plant which is in the mutative period. This deVries succeeded in doing in the case of Lamarck's evening-primrose (*Oenothera Lamarckiana*). The most important point in experimenting is to know accurately the pedigree of the plants used. Elementary species are found in nature, but their history is not known and their origin was not observed.

Since Linnaeus species have been considered the units of nature. Previous to his time the genera were the units, and nearly all the common names of plants—oak, clover, rose, refer to genera. Now we must recognize the fact that the real units are the elementary species.

The species of the systematists are nearly always compound groups containing from two to fifty "or even hundreds of well differentiated forms." Some authors recognize more of these elementary forms than do others. Bentham and Hooker, for example, describe the bramble under five species, while Babbington makes forty-five species out of the same material. *Draba verna* comprises over two hundred elementary species (p. 51).

Among cultivated plants elementary species are found in the beets, apples, pears, clover, flax, cocoanut, wheat, oats and others. Wild apples are at present very rich in elementary species. All cultivated plants came from wild ancestors, and different elementary species among these wild forms gave rise to different types of the cultivated plants. Of course artificial selection of individual variations has been one of the chief factors in producing the different varieties.

Two kinds of breeding selection, first distinguished by Von Rümker, must be recognized.

1. Production of new forms. These are produced by nature without

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* New elementary species also result from crossing, but this part of the theory, elaborated in Vol. 2 of the *Mutationstheorie,* is not treated of in the English work.

man's aid, and "have only to be selected and isolated, and their progeny at once yields a constant and pure race."

2. Race improvement. This is the work of man. Nothing new is created, but what already exists is developed and improved. Progression is counteracted and the race brought above the average. This is the process commonly designated as variety testing.

This discussion serves to illustrate again the fact that natural selection, operative through the effects of climate, soil and water supply, does not create anything new, but acts as a sieve, conserving the fittest species and letting the unfit perish. Discontinuous variation is evolution. Natural selection makes permanent the victory won by the newly evolved form. Mutation produces the combatants in the struggle for existence and the result of the conflict is the survival of the fittest species.

C. S. G.

(*To be continued.*)

Organic Evolution,* by Professor Metcalf, embodies the author's lectures of this subject to the students of the Woman's College of Baltimore. We learn from the preface that the writer has endeavored "to avoid technicality as far as possible, and present the subject in a way that will be intelligible to those unfamiliar with biological phenomena." This aim has been successfully accomplished. The book is beautifully illustrated, partly by colored plates. Possibly too much dependence has been placed upon the illustrations. They are fully explained, but one seems to need the lecturer with pointer to make their relation with the text more intimate. The book will prove to be interesting and instructive reading, especially for those for whom is it primarily intended. It is by far the most attractive popular presentation of the theory of organic evolution. We venture the prediction, however, that future works on this subject, whether technical or "popular," will devote less space to the debatable ground of protective coloration, mimicry and closely allied topics, and more to variation and the experimental study of the origin of species. It is with these questions that the next generation of biologists will be chiefly concerned. The appendix contains valuable suggestions for a course of reading in "organic evolution and phenomena of special adaptation."

C. S. G.

*An outline of the Theory of Organic Evolution, by Maynard M. Metcalf, pp. xxii and 191. The Macmillan Co. 1904.

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A TRIP TO THE INAGUAS.

By George V. Nash,
New York Botanical Garden.

(*Conclusion.*)

The second class of scrub plants, the herbaceous and succulent species, are in the minority. Of herbaceous plants there are very few—several species of the Amarantaceae, some grasses and a few sedges. They are conspicuous by their absence, and form a very small percentage of the whole.

The succulents, represented by the cacti and an agave, are, for the small flora involved, richly represented. They form a conspicuous feature of the scrub, being universally distributed through it, and indicate the xerophytic nature of the formation. There are five species of cacti in all, as follows: two of the genus *Opuntia,* one of these, *O. Nashii,* arborescent, twelve feet tall or more, with red flowers, the other the widely distributed *O. Dillenii* with rich yellow flowers; one *Pilocereus,* with tall grey-green pipe-like stems, sometimes ten feet high, probably endemic to the islands; one *Cactus,* globular in shape and of a striking brown-green color, quite unusual and pretty; and a *Melocactus.* The *Opuntias* and *Pilocereus* were generally distributed on both islands, as was also the *Cactus,* but not so plentifully. The *Melocactus,* however, was much more restricted in its range, being confined, so far as our observations went, to a portion of the scrub at Moujean Harbor, Little Inagua, and to a small area of the same formation on the south shore of the large island, at

Lantern Head. Occasional isolated plants were met with elsewhere, but even then they were within the scrub. At Moujean Harbor we saw this cactus formation at its best development—all five species being in evidence. The accompanying illustration (Fig. 21) shows the *Melocactus* at home on Little Inagua. These grew on the solid rock, sending out their long slender roots over the hard surface seeking for nourishment, and their root branches down into crevices and cracks in this food hunt. Occasionally a plant would be found lying on its side, apparently not discommoded in any way, growing along vigorously, as though that were its normal way of doing things. The Turk's-head, as the *Melocactus* is commonly called, is a grotesque-looking object. In plants of middle age, just about sending forth the portion which bears the flowers, this has some resemblance in shape and color to the Turkish fez, hence the popular name. This portion soon elongates, however, and in old plants often attains a length of a foot and a half and fully six inches in diameter. It is cylindric, firm in structure, and densely armed with spines of a rich red

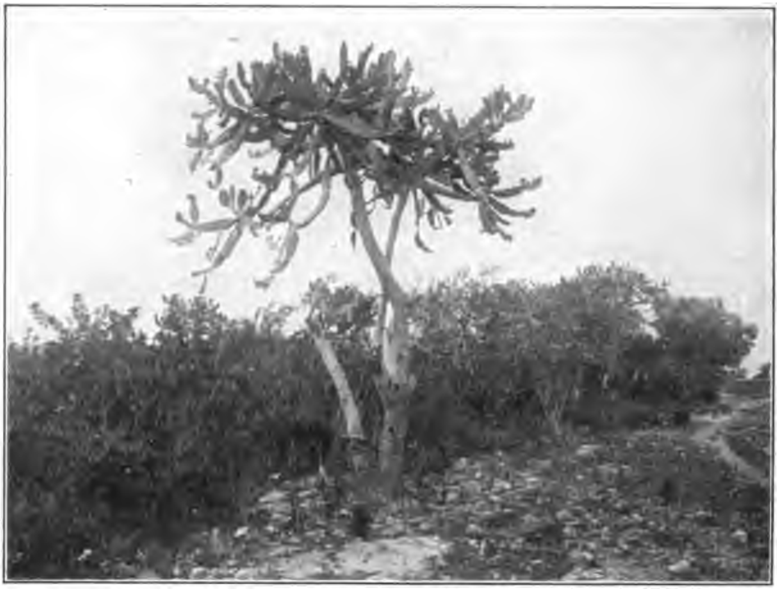

FIG. 23. An individual of *Opuntia Nashii,* a tree-like prickly-pear.

color. Interspersed with these spines are masses of woolly hairs, and it is from this combination of wool and spines that the flowers make their appearance, and afterward the bright pink fruits a half inch or more long. Plants from only an inch or two in diameter up to those with cone-shaped bodies sometimes two feet tall were of frequent occurrence here at Moujean Harbor. By all odds the finest specimens were observed here.

The *Agave* referred to above was also distributed throughout the scrub, but not so generally as were the cacti. An exception must be made for Moujean Harbor in this respect, however, for here it was one of the most conspicuous features of the scrub. Its foliage was of a grayish green, much resembling the color of the common century plant. Another element here, and a most striking one on account of its apparent discord with the general note struck by the cacti and agave, was a palm, *Thrinax keyensis,* first discovered some years ago on the Marquesas Keys just to the westward of Key West. Here it grew in great profusion in the scrub, rising up out of the bare rock. It attained a height of six or eight feet. Taking a stand on one of the little eminences in the scrub at Moujean Harbor and looking out over the island one was struck with the prevalence of these three plants, which seemed to stand forth like giants among a lot of pygmies: the tall grey pipe-like stems of the *Pilocereus,* rigid, erect and unyielding; the tall candelabra-like stems of the *Agave,* adding a touch of our own southwestern country; and the silvery fan-like leaves of the palm, firm and unyielding in structure too, but furnished with long slender petioles, so that every breeze made them sway too and fro, their hard surfaces rubbing together producing a most distinct rustle.

Bromeliads were of frequent occurrence, sometimes growing in considerable profusion. These were all members of the genus *Tillandsia.* One of these, the Florida moss, *Tillandsia usneoides,* was observed in but one locality. This was at James Hill, where it hung in elegant festoons, casting a delicate shadow over the cacti which sprang up from the bare rock below. To one who has been accustomed to see this in quite different surroundings, it seemed entirely out of place here. Orchids, represented by the genus *Epidendron,* occurred in great abundance in some portions of the scrub. These frequently formed large masses on the bare rock, or firmly fixed themselves in clumps on the sides of the tree trunks. Here again was a surprise to one who was used to seeing orchids in rather humid situations—here they were in a region where cacti flourished. At one place on Little Inaugua this was emphasized by finding great masses of *Epidendrons* and *Agaves* growing side by side, both apparently perfectly at home and thriving equally.

Another palm, originally discovered in Florida, was found quite abundant in the scrub at one place. This palm was *Pseudophoenix Sargentii,* fruiting here when six or eight feet tall. Its discovery on Inagua extends its known range about 300 miles farther to the south. It is known by the natives as " mountain cabbage," probably on account of its being found on slight elevations.

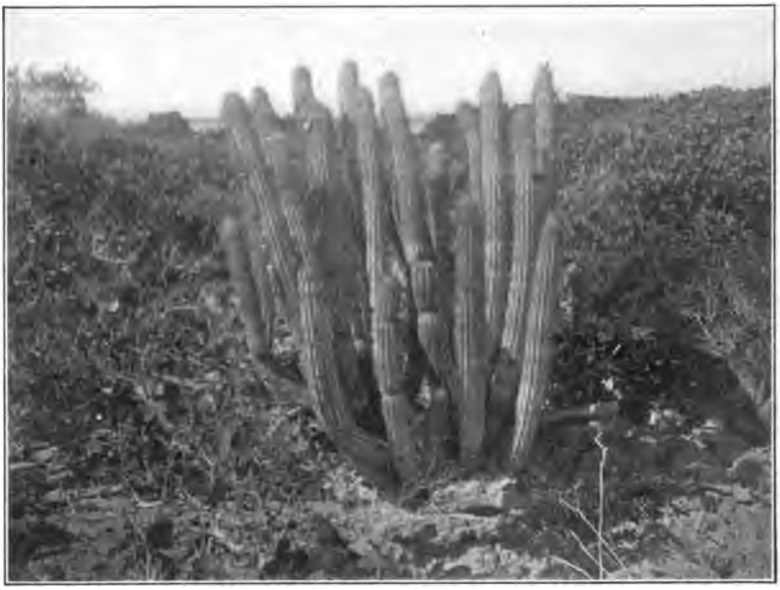

FIG. 24. A species of *Pilocereus;* the fruit may be noted on the stem at the left.

The flora of the scrub formation comprises by far the greater number of the species, and of those endemic to the islands practically all are found here. This flora is very uniform, the species being generally distributed throughout the islands, so that a collection of specimens made at any one point would include the greater part of the flora. At most every place we touched, however, a few species would be found which had not been encountered elsewhere, so that to have a complete representation of the flora would require a pretty thorough exploration of the islands. Much more of interest could be written in relation to this unique portion of the flora, but I wish to devote some space to the other formations of the islands.

Turning now to the savannah formation, you have an extended grassy plain, dotted here and there with island-like masses of timber, often twenty-five feet high, called coppices. It is in these coppices that the islanders secure their best timber from the mahogany trees, *Swietenia Mahagoni*, which form a large part of their growth. The grass which covers these savannahs, known to the people as "savannah grass," is *Sporobolus Virginicus*. Herds of wild horses and donkeys find here their main food supply. While on the subject of the savannah I wish to speak of the large salt lake whose western end impinges upon what is known as the Upper Savannah. This is a large body of salt water, with no visible inlet or outlet I was informed. It was not indicated at all upon the navigator's chart I had with me. It is said to be eighteen miles long, about six miles wide, and five or six feet deep. On account of the indefinite information in my possession I have indicated the position of this lake on the accompanying map by a dotted line. It appears to be a portion of the savannah flooded, for the same coppices dot its surface as islands.

Other smaller savannah-like areas are found scattered through the scrub. One of these was Cabbage Pond, about three miles south of Camfield Bay on the north shore of Great Inagua. Here the soil, a mixture of sand and loam, must have been of considerable depth, for it supported a grove of palms, the trees fifteen or twenty feet high. This is said to be the same palm found in our southern states, *Inodes Palmetto,* and called there the "cabbage palm." On Inagua it is known as the "pond thatch." Its leaves are very durable and are used for thatching; they are said to last for twenty years.

In the immediate vicinity of this so-called Cabbage Pond, is an example of what the inhabitants call a "fountain." This particular one is a body of fresh water, seventy-five or a hundred feet in diameter, fringed all around with a border of saw-grass and shrubs, and infested, at least at the time of our visit, with mosquitos. The water was of an inky blackness, not at all inviting as a drinking place. This blackness, however, was not due, as I at first suspected, to impurities, but was the result of the great depth of the water. I was informed by our guide that soundings had been made but without success in reaching the bottom. Another of these small savannahs was seen at Smith's Thatch Pond, on the south side of the same island. Here was again found the same palm, growing in great profusion, and the same brand of mosquito, judging from his ceaseless activity and penetrating powers. Standing on the edge of this savannah, and looking out upon the rich tropical effect produced by the palms, one could

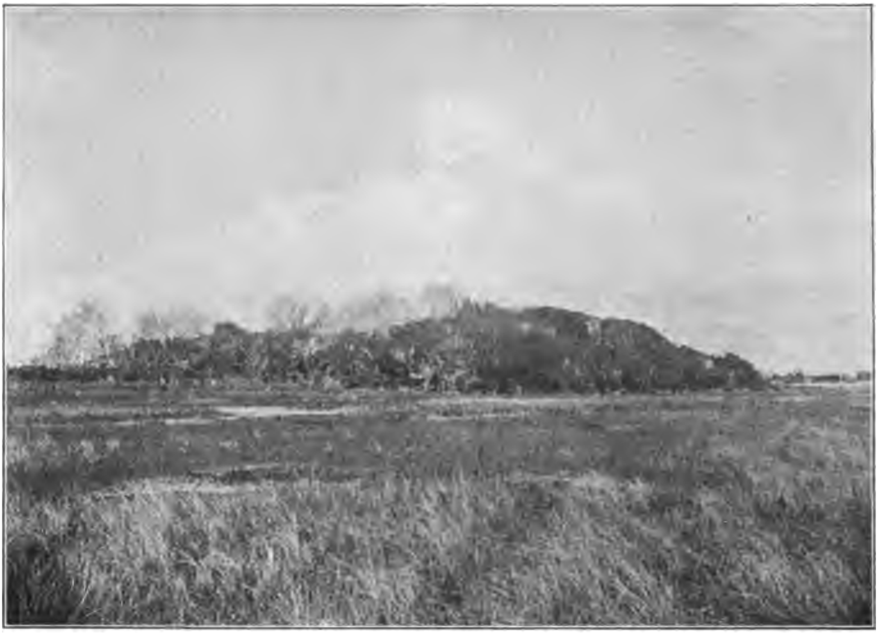

FIG. 25. Savannah formation, with a coppice in the background. View in Upper Savannah near west end of Salt Lake.

hardly realize that a few steps in any direction would again take him to the scrub, dry, arid and monotonous.

The " white sand " ridges are laid down on the rocky floor of the island, and appear to be of sand-dune formation. They usually occur near the shore, which favors this idea of their origin. The vegetation is larger here than on the scrub, due to the greater amount of soil perhaps, but it is certainly a poor quality of soil. One of these " white sand " areas at N. W. Point, Little Inagua, however, supported a dense growth of trees some twenty feet tall. The soil here was a mixture of sand and humus, much resembling that of the pine woods of our southern states. It was here that we found *Canella Winteriana* growing, its only known occurrence on the islands. It is known to the natives as " cinnamon." In most parts, however, the " white sand " ridges are characterized by the great abundance of a palm, related to *Coccothrinax jucunda.* It grows by the thousand in these areas, its tall slender trunks, usually but little over two inches in diameter and sometimes fifteen feet tall, bearing aloft a crown of rich green leaves, silvery on the lower surface. It is considered of little economic importance by the negro population.

The salina formation is closely related to the savannah, but its soil appears to differ somewhat. It is apparently formed of the wash from the sandy and rocky ridges, the resulting compound being a clay-like mass very sticky when wet. It is apparently quite salt, as it supports a salt-loving flora. The prevailing shrub is the white mangrove, *Avicennia nitida,* its aerial roots sticking up like little spires in great profusion all around the plant. Some black mangroves, *Rhizophora Mangle,* are found here. Great quantities of one or two species of *Salicornia* abound also.

The last formation is that of the strand. This does not differ from that in all parts of tropical America. The sea lavender, *Tournefortia gnaphalioides,* the curious leaf succulent, *Batis maritima,* the sea-beach morning-glory, *Ipomoea Pes-Caprae, Sesuvium Portulacastrum,* are the more characteristic elements.

It may be asked, what do the inhabitants do to pass away the time? It is true that amusements in a place of this size must be limited. Places of public resort there are of course none. There are the tennis courts and the cricket field, and as summer reigns the year around there, these are always available. They have their social affairs there as elsewhere, and in a community as small as this they feel dependent, each on the other, to make these events successful. To those who enjoy the hunt the island of Inagua offers many inducements. Hundreds of wild cattle roam the scrub, probably the offspring of domestic animals which have succeeded in getting ashore from wrecks in times gone by—at least so it is explained by the people there. The hunt for these furnishes most exciting sport, and the element of real danger accompanying it lends zest to the enjoyment. I heard many tales while there of dangerous encounters with wild bulls and hair-breadth escapes from infuriated cows. Wild hogs abound, supposedly of an origin similar to that of the cattle, and boar-hunting furnishes a sport only second to that of the hunt for wild cattle. Then there are the large numbers of wild horses, already referred to, roaming over the savannahs, untamed and free—wild and intelligent, and not to be caught but by the greatest perseverance and skill. This is the source from which is derived their beasts of burden, for donkeys and mules too abound in a wild state. There is plenty of fishing for those who enjoy that sport, and shark-fishing, or rather hunting, has its allurements. Beautiful transparent water and sandy beaches furnish frequent opportunity for ideal sea-bathing. The botanist, and I presume also other scientists along their line, there is much to interest. Many unfamiliar plants, some of them hitherto unknown to science, are met on every side. To the student of ecological problems it would offer a most interesting field, for one has really desert conditions on a sea island, in a tropical climate, and a desert intimately surrounded by water must require special adaptations to meet the rather unusual conditions.

ON THE NOMENCLATURE OF FUNGI HAVING MANY FRUIT-FORMS.

By J. C. Arthur,
Professor of Botany, Purdue University.

(Conclusion.)

This lack of agreement among mycologists is significant of the historical form of the concept underlying the application of names, which does not differ materially, as exemplified by conservative mycologists of the present time, from that held by mycologists of a century or more ago. In pre-Linnaean times names consisted of descriptive phrases; thus Micheli in 1729 placed under the newly established genus of *Puccinia* two species, *i. e.:* (1) *Puccinia non ramosa, major, pyramidata,* and (2) *Puccinia ramosa, bifurcata, omnium minima, candissima, pruinam referens.* Sometimes a name would be formed of only two words; as in Schmidel's work of 1797, written in the pre-Linnaean style, we find *Puccinia cristata.* But this was purely accidental, and not intended to be a concession to the binomial method introduced by Linnaeus. Schmidel evidently considered the term *cristata* sufficiently descriptive of the fungus, and that additional terms would be superfluous. It was Linnaeus' great contribution to nomenclature that he restricted names to two terms, one generic, the other specific. By this change he did not eliminate the descriptive idea embodied in the name, but he did superpose the appellative idea. When Persoon changed Micheli's *Puccinia non ramosa, major pyramidata* to *Puccinia Juniperi,* he intended not only that the name should designate a certain kind of fungus, but that it should apply to a fungus found upon the juniper, and belonging to the group of fungi embraced under the name *Puccinia.* Let it be noted that the generic name in this case is not descriptive. The genus *Puccinia* was named in honor of Puccini, a Florentine professor. From the very beginning of binomial usage the descriptive feature of generic names has been wholly incidental, but the descriptive feature of specific names has persisted with unabated force with most nomenclaturists. In Sydow's monographic work upon the *Uredineae,* the first volume of which is but just from the press, we find that the author changes the name *Puccinia Distichlidis* E. & E. to *P. Kelseyi* Syd., because it has been found that the host is not a species of *Distichlis,* as at first supposed, but *Spartina gracilis,* and the name is therefore no longer appropriate and will moreover give cause for confusion. Dr. Sydow says that in this he is quite in agreement with the majority of mycologists, that in fact new names have also been chosen by others in analogous cases. I have cited this instance to show that the descriptive feature of the specific name is still often considered of much and even of controlling importance. But it was early seen that instability would result if appropriateness were made the test in retaining or rejecting a name, and in the Paris code of 1867 changes based upon such a reason were, with some exceptions, prohibited. The tendency has been to give less and less weight to the descriptive feature of the name in determining correct usage, and correspondingly more weight to the appellative feature. In some of the recent attempts at writing or revising rules to govern botanical usage, this tendency has been carried to a logical conclusion, and while the author of a name is expected to exercise all care in its selection, that it may be as descriptive, or as significant as possible, yet when once published, the nomenclatorial treatment of the name does not consider its meaning but only its right to designate a certain object, and that object is the species indicated by the specimen which the author employed to represent it.

The idea of using a type or representative of the species, to which reference can be made whenever it is necessary to determine the true application of the name, is of recent origin. It is recognized that the type may be destroyed, lost or inaccessible, and in such cases the character of the type must be determined by the best circumstantial evidence available. But in the majority of cases the type specimen is in existence. By the use of types the original application of a name is more accurately ascertained than by any device heretofore suggested.

But it is rare or never that a specimen represents all the characteristics of a species, and the description which is drawn from such specimen is consequently and inevitably incomplete. But the name, nevertheless, applies to the whole species, to all its variations in aspect, to every member of the species, and to each individual in all stages of development, and in all its structural parts. The fact that the author of the name, in establishing it by a published description, did not mention all the characters to be derived from the various parts of the plant, or its various stages of growth, does not in the least invalidate the name, or restrict its application. The author may have been ignorant of some of the characters, or have misunderstood others, and yet the name is not invalidated or restricted. The name of a species is the name of the whole species.

When a name is applied to a part of a species, that is, to the species in a certain stage of development, or when it assumes certain appearances, or when it is applied to similar parts of several species, it stands for what is known as a form species. When the same method is pursued with genera, we have form-genera. Such species and genera compose the very large group of forms known as *fungi imperfecti,* and they are not uncommon among many families of fungi, and of other plants as well. Such names are necessary and useful until greater knowledge of the plants can be obtained, and their true relationship be established.

If we turn now to the example with which we began, and undertake to decide from which of the names applied to the wheat rust, *Aecidium* (*Lycoperdon*) *poculiforme, Uredo* (*Lycoperdon*) *lineare* and *Puccinia graminis,* the specific name should be taken in order to accord with modern usage, it will readily be seen that the selection will depend in the first place upon the conception held regarding the genus *Puccinia.* If it is correct usage to restrict the specific name to that applied to the teleutosporic stage, because Persoon in founding the genus, and mycologists of more recent times as well, have drawn the characters chiefly from the teleutospores, then the name should be written *Puccinia graminis.* But if this is accepted, the genus *Puccinia* is not a true genus, but a form-genus, for it represents only one of the three stages of development. If it is a true genus, it embraces all stages of development, without regard to the number or selection of the generic characters, and under this view the name should be *Puccinia poculiformis,* as this is the oldest specific name applied to any phase of the species. But Magnus and Saccardo hold that this would imply that Jacquin had intended to include the teleutosporic stage under his name *poculiforme,* which of course is untrue; and Saccardo further holds that it would also imply that the teleutosporic stage, which the genus chiefly signifies, assumes the form of a cup, a form which it does not exhibit. Both of these objections lose all their force, however, and become inapplicable, if the name is held to be simply appellative and to apply to the whole species, irrespective of the characters originally used to establish it.

Under this view it does not matter whether the different stages of development are closely associated as in the case of *Uredinopsis mirabilis,* cited by Magnus, or wholly dissociated as in all heteroecious species, of which *Puccinia poculiformis* is a good example. Under this view it would be possible to select the generic name, as in the case of the specific name, from all those that have been applied to any phase of what is now held to constitute the genus, whether that name was originally applied to an imperfect stage, or to what is now believed to be a perfect stage. The fact that the generic names of the Uredineae have not yet been so adjusted is no reason that they should not be so adjusted. Under such a conception of the application of generic and specific names, there remains no objection to placing the Uredineae, and all other fungi, under the same laws for nomenclature as are found serviceable for higher plants.

I could doubtless make the meaning of my contention more evident, and the breadth of its application more certain by citing a variety of examples, but instead of doing so I will illustrate by an analogy that may answer nearly as well and be less tedious.

There is not much similarity in the names of persons and of plants, but as means of identification, which is their chief use, they serve the same purpose in each case. If Mr. and Mrs. Gardner name their daughter Rose, she continues to bear the name, even though in after years it becomes obviously inappropriate. She is christened simply Rose, and is baptized as Rose, yet her full legal name is Rose Gardner, by virtue of her relationship in the Gardner household. When she is married, it is again simply as Rose, but her full legal name now becomes, we will say Rose Goldsmith: she has changed the household to which the law accredits her. A like change in name will take place each time she remarries.

This is very similar to what happens in the case of plants. Some responsible person gives the name of *Roseus* to a plant, and places it in the *Uromyces* household. Its full legal name is now *Uromyces roseus.* But after a time someone discovers that its affinities are more properly with the household of *Puccinia,* and publishes the fact. The name now becomes *Puccinia rosea;* and it might thus be changed a number of times. We see that the christian name on the one hand, and the specific name on the other, receive, as appellations, almost identical treatment, and that the relation which the christian name holds to the surname is in all essentials the same which the specific name holds to the name of the genus. The treatment of personal names is in some respects more satisfactory than accorded plant names, in that the descriptive use is wholly subordinated to the appellative use, and the relationship of the two parts of the name is better appreciated.

It would seem that when mycologists generally accept the idea that the name of a plant applies to the whole plant in all its stages, irrespective of the manner in which the name became established or legalized, that after it becomes subject to the laws of nomenclature it is simply appellative, and that the two parts of the name have quite different values, the way will be clear for the uniform operation of priority in the case of fungi with many fruit forms as well as in higher and less obviously complicated plants.

EARLY WILD FLOWERS.

By Wm. Whitman Bailey,
Professor of Botany in Brown University.

There is one period of the year when even the most unobservant person awakens to some kind of nature love. After the last weary days of winter, and this year they have been exasperating, the first green things, or budding flowers, are hailed with delight. It may not then be amiss to speak, in an informal way, of some of these humble companions of our journey, who do so much to enliven the way.

The earliest of our wild flowers, if anything so small can be dignified by the name of flower, is *Draba verna,* whitlow-grass. It is an introduced weed and represents the cress or mustard family, the "cross-bearers" of the floral procession. Its chief charm is in its precocity and endurance of cold. We love anything that dares to brave the winds of March. Our native flowers, with few exceptions, put off their appearance in the northern states till April or May. Nature first frolics with tassels, and there is method in her madness. Shrubs, like the alder and hazel, have their pollen carried by the wind and lo! when they open, the wind is on hand to serve them! The skunk-cabbage, however, which is freely visited by insects, even by bees, blossoms as soon.

The may-flower or trailing arbutus, is the earliest pretty flower. Far be it from us to "gild refined gold or paint the lily," by adding one word to its praise. Poets, good and bad, have sung it; prose writers have preached it, "*tamen vivit.*" Yet, somehow, despite the formal bouquets into which it is tied up for sale, it charms one still. To see it one should visit it in its own home.

The hepatica holds even a dearer place in our estimation. It has not the fragrance of the *Epigaea,* but is yet not wholly devoid of perfume. It possesses a grace and beauty, a piquant liveliness all its own. The hepatica, too, chooses such entrancing surroundings, woody dells, and mossy rocks, where the flowers seem to be playing hide and seek.

About the same time there appear the bluets (*Houstonia* *caerulea*), prodigal in abundance, drifting in downy masses over the meadows, these little plants are a perennial joy. No one can be unmindful of these "quaker ladies" (another name for them), so modest, pure, and simple.

Then, there is the saxifrage, the rock-breaker, with its white clusters of inflorescence. Not so abundant here as in some places, it is often a distinct feature of a hillside, sharing the honors with the columbine, the five-finger and the sagittate violet.

The blood-root, too, is an early comer. Already its "baby pearl" is displayed in our yards—enwrapped by its crinkled leaf. This later grows to at least four times its present size. When the columbine arises, nature is in a mood for more decided color, though she was yellow from the start, in marsh marigolds, coltsfoot and dandelion. She is particularly happy in the columbine, touching it always with dainty fingers, and setting it off to best advantage on cliff or hillside. Bees and boys discover the honey in the long, knobbed spurs.

Such is the opening of the year. When May is somewhat advanced, the flowers troop in too fast to be collected or enumerated. They always, however, permit a bow of recognition.

BOTANIZING IN BRITISH COLUMBIA.

By Charles H. Shaw,
Professor of Biology, Ursinus College.

Eastern British Columbia, the Selkirk country, is a region whose vegetation is comparatively little known. Considerable botanical investigation has been done in Montana, which lies next to it on the south, and several bontanists have collected along the line of the Canadian Pacific Railroad which pierces the region, but aside from this almost nothing has been done. About a year ago the writer began to organize an expedition for the purpose of enlarging our knowledge of the plants of this district. The plan was advanced by the support of the Medico-Chirurgical College, and in June a party of five of us left the railroad at Field,

B. C. It was the intention to have made the Yoho Valley the first center for work, but snow still filled the passes leading northward and so we were obliged to stop at Emerald Lake.

The vegetation around us was astonishingly like that of northern Europe. The forests of spruce and pine, larches at higher altitudes and unimportant maples and poplars, cryptogams such as *Lycopodium complanatum, Botrychium lunaria, Dryopteris Filix-mas,* and a host of herbaceous genera gave a facies which repeatedly called forth from our German member the exclamation, " ich fühle mich zu Hause."

The forests of the Selkirks are commonly said to greatly surpass those of the Rockies in size of trees and luxuriance of growth. Now while a marked difference indeed exists between the western flanks of the former and the eastern slopes of the latter it is by no means correct to assume that the dividing line between the two mountain systems is also the line of demarcation between the regions of large and small trees. This will be made clear from the notes of two or three days of a memorable journey in July.

We had started from a point on the upper Columbia, with a pack train, to push westward into the Selkirks. Around us was a forest exactly like that of the Rockies—mostly pines and spruces, as a rule not reaching more than eighteen inches in diameter, with a sparse undergrowth. This condition continued for days. A photograph taken after we had covered two thirds of the distance from the outskirts to the center of these ranges shows the same small trees and a forest floor sufficiently free of undergrowth that over it a horse might gallop. But one morning as we were approaching the very center, a change suddenly became manifest. Arbor vitae and hemlock began to appear, all the trees shot skyward and among them were individuals of noble girth. A vigorous growth of bushes and weeds cut off all view and we pushed our way among bracken and spleenwort ferns nearly as tall as ourselves. Near the streams almost impenetrable growths of alder and willow made us the more clearly realize that we had passed into a new zone. Later we found, still farther westward, arbor vitae of a circumference of twenty-five and thirty feet.

All told we spent seventy-eight days on the march and in camp, much of the time in territory never before seen by a botanist. Once for nearly three weeks we did not see a face except of our own members. We obtained a considerable mass of data concerning the vegetation, and brought back about twenty thousand sheets illustrating the flora of the region.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

ON THE ZONAL DISTRIBUTION OF SOUTH ATLANTIC AND ANTARCTIC VEGETATION.—The *Geographical Journal* for December, 1904, contains an interesting article by C. Skottsberg under the above caption. This is a preliminary communication on the phytogeographical results obtained on the Swedish Antarctic Expedition. The old *Flora antarctica,* including Tierra del Fuego, South Georgia, the Falkland Islands, Kerzuelen Land, the Aukland group, Graham Land and adjacent territory, is divided into two zones: (1) The Austral zone (Tierra del Fuego, Isla de los Estados, Falkland Islands, South Georgia, and the South Sandwich Islands (probably)); (2) The Antarctic zone (South Orkney, South Shetland Islands, and Graham Land with its surrounding group of islands).

The climate of the Austral zone permits the existence of forests and grass land, while a cold desert is the result of the climate of the Antarctic zone. In Tierra del Fuego the vegetation completely corresponds to the climate. The forests are green in summer and quite like those of Scandinavia in winter. There is no moss carpet, but the bushes in the woods here and farther south are evergreen.

On the Falkland Islands there does not exist a wild tree, the ground being wholly occupied by a boggy grass land. The total rainfall is sufficient to make a deciduous forest, but is too evenly distributed throughout the twelve months. There is no ground covering of snow in winter and spring, and the region is swept by strong and cold southwest winds. These climatic features doubtless account for the absence of forest vegetation.

At South Georgia (Lat. about 54° S.) with 38.9 in. annual precipitation there is a great paucity of phanerogamic species, and those that are found are the same as those in Fuego and the Falkland Islands. Cryptogamic species are very numerous and mostly endemic.

The South Sandwich Islands (between Lat. 55° and 60° S.) have never been visited by scientists.

The Antarctic zone is a cold desert zone. The summer is cold, the ground frozen for nearly the entire year, and the wind very formidable. Neither the forest nor the grass vegetation are dense. The richest flora is on the islet at the northwest coast of Louis Philippe Land. Only one phanerogam (*Deschampsia antarctica*, Hook.) is found, and that rarely. The mosses and lichens do not form a carpet, but grow only in small tufts in fissures or between stones.

There is a great similarity between Antactic and Arctic species. Of the ocean plants the Austral algae have floating fronds, but, with the sole exception of *Marginaria jaquinoti* (Mort.), which floats when torn off from the bottom, types with floating fronds are wholly absent from the Antarctic zone. This is due to the ice conditions. Calcareous algae occur in large numbers.

C. S. G.

TRANSPIRATION IN XEROPHYTIC LEAVES.—*That xerophytic leaf structure is not always incompatible with abundant transpiration* has been demonstrated by Joseph Y. Bergen* from a study of the leaves of a number of broad-leaved evergreens in the Mediterranean region. These trees were chosen for examination because their leaves are active and exposed to illumination for a considerable period, and because *the same tree* affords good material for comparative experiments, since some of the leaves are developed in bright sunlight, and others in deep shade.

The sun leaves showed the usual xerophytic characters. They are smaller, and narrower in proportion to their length, than the shade leaves. Their margins are recurved, and the under surface is strongly concave. They assume the vertical position, while the shade leaves grow more horizontally. The sun leaves are invariably the thicker. In those species which are pubescent or scaly on the lower surface, the hairs or scales are much thicker on sun leaves. The stomata, also, are more numerous. There is a more highly developed cutinized layer of upper epidermis in sun leaves; and a double layer of palisade cells, with but a single layer in the shade leaves; moreover, the intercellular spaces in the upper mesophyll are less extensive in the sun leaves.

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* Bergen, Joseph Y., Transpiration of Sun Leaves of Olea Europaea and Other Broad-Leaved Evergreens. Botanical Gazette, vol. **38**: 4, Oct., 1904.

To ascertain the relative amounts of transpiration in the two kinds of leaves, the freshly cut ends of leafy twigs were immersed in water contained in small test-tubes. Each stem, coated with wax to prevent evaporation, was sealed into its tube, air being admitted through a capillary tube alongside the stem. Observations were made out of doors, on sunny days, at a temperature of about 21° C., and a relative humidity of 67 per cent.

With each kind of leaf under normal conditions, the sun leaves were found to transpire considerably more than the shade leaves (from 3 to 10 times as much), and the same general result was obtained when shade leaves were placed in full sunlight, or sun leaves in the shade.

It is suggested that the sun leaves, being the more vigorous, are better able to transpire large quantities of water, and that their greater thickness gives them more interior evaporating surface, the xerophytic structure existing only for use in emergencies to protect the plant from injurious loss of water.

These results are especially interesting because they are contrary to the generally accepted theory that xerophytic leaf structure precludes abundant transpiration.

M. M. B.

REVIEWS.

Species and Varieties: Their Origin by Mutation.*

II

Chapter V. makes clear the idea of retrograde varieties. While elementary species "arise by the acquisition of entirely new characters," varieties have their origin either "by the loss of existing qualities or by the gain of such peculiarities as may already be seen in closely allied species." "The elementary species have mutated in the line of progression, while others have diverged from their parental types on a line of retrogression, or in the way of repetition." The latter are termed "retrograde varieties." For example, among the composites there is a group of genera, among which the daisy, yarrow, and aster are examples, having both disc and ray florets. Another group lacks the ray florets, *e. g.*, the tansy, and some artemisias. Among the daisies and asters, however, some forms are found in which the ray florets are lacking. These "discoid" forms are retrograde varieties. Among the tansies, on the other hand, ray flowers are sometimes observed. These "radiate" forms show characters already existing in closely allied species, and are progressive varieties. Sugar corn is a retrograde variety resulting from loss of starch in the kernel, and its replacement by sugar or some allied substance. Here also belong weeping willows and other weeping trees, which have lost the power of upright growth of the branches.

Atàvism.—Oftentimes plants revert to some supposed prototype. Reversion of this kind is ***atavism.*** It is usually impossible to prove that the type towards which reversion has taken place is the parent species. We have ordinarily only indirect evidence on this point. If we could have a plant with a pedigree and it should occasionally revert to an ancestral form, then we shall have a case of real atavism. Before designating such a variation as atavism we must be sure that the race is pure, not hybrid, otherwise Mendelism, or a splitting of a hybrid generation into its parent types, may be confused with atavism.

Reliable, well-authenticated reversion by seeds is extremely rare, for in most of the recorded instances there is grave doubt as to the purity of the seeds and the possibility of unobserved crosses. Apparent atavism might result also if the supposed prototype were a hybrid. On these grounds, bud variations, only, are accepted as direct proofs of true atavism. As examples of true atavism may be mentioned the cut-leaved varieties of different plants, as the birch and beech, which often develop, from buds, stems having the ancestral character of entire leaves. "But this is merely due to the wide variability of the degree of fissure and is to be considered only as a fluctuation between somewhat widely distant extremes, which may apparently include the form of the common beech leaves. It is not a bud-variation at all, and it is to be met with quite commonly while the true reversions by buds are very rare and are of the nature of sports appearing suddenly and remaining constant on the same twig," p. 179.

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* Species and Varieties: Their Origin by Mutation. Hugo deVries, edited by D. T. MacDougal. Chicago: The Open Court Pub. Co. 1905.

Vicinism.—The rare phenomenon of "true atavism or reversion caused by an innate tendency," must be carefully distinguished from *"false atavism,"* which results from crossing with neighboring plants. This is the "atavism" of the breeders, but since it is quite a different process from true atavism, it is proposed to give to it the term *"vicinism"* (Latin *vicinus,* neighbor). The fact of vicinism as distinguished from true ataism has been established by different experiments with *Aster Tripolium,* creeping thyme, and white self-heal.

Latency.—A common phenomenon of plant life is latency, or the lying dormant of one or more characters through several generations, with subsequent reappearance. There may be the ordinary type, individual latency, which may show itself from time to time during the life history of an individual, as when the characters of seed leaves, or cotyledons, lie latent in the tissues of the plant from germination to the development of the next embryo, or when willow and oak trunks produce shoots. We may also recognize *systematic latency,* manifest only at intervals in the lifetime of the species or variety This has no regular periodicity and may not be excited by artificial means. True atavism is a case in point.

"Wheat ear" carnations, and green dahlias revert, not to the characteristics of the ordinary species, but to the particular variety from which they have sprung, showing that these varietal qualities must have been present in the wheat-ear plants (and in the green dahlias), but latent.

The facts of latency have a direct bearing on the question of the difference between species and varieties. Negative, or retrogressive, varieties result when some character of the species becomes latent—*e. g.,* white varieties of colored flowers. "Positive varieties on the contrary owe their origin to the presence of some character in the species in the latent state, and to the occasional re-energizing thereof," *e. g.,* colored or tinted varieties of a white species. In such a case it is nearly always the rule that the color or tint of the variety occurs in other species of the genus, and the inference is that it was latent and only apparently lacking in the white species.

A systematic species is composed of elementary species which are of equal rank and not derived from one another, while varieties of a species are "derived from real and still existing types." The method by which elementary species arise is termed *"progressive evolution,"* in contrast to *"retrograde evolution,"* which proceeds by the loss of latency of characters, and *regressive* (*degressive*) evolution, where a latent character reassumes its activity and returns to the active state (p. 221).

In all three of the above cases the important fact is that "the differentiating marks show more or less clearly that they are made up of units." "Transitions are wholly wanting, although fallaciously apparent in some instances owing to the wide range of fluctuating variability of the forms concerned, or to the occurrence of hybrids and subvarieties." "These physiological units, which in the end must be the basis for the distinction of the systematic units may best be designated by the term of 'unit characters' (p. 249). Their internal nature is not yet known. The fact receives repeated emphasis that *both species and their characters are discontinuous.*"

The study of hybrids affords means for a better distinction between elementary species and varieties, for the two behave in quite different ways when subjected to crossing. The cases considered are, "the crosses between elementary species of the same or of very narrowly allied systematic species, on the one side, and on the other, . . . to the crossing of varieties with the species, from which they are supposed to have sprung by a retrograde modification." Crosses of different varieties of the same species and of progressive varieties are omitted.

In the inter-crossing of varieties, as in normal fertilization, all unit characters are paired (even though some may be dormant in either of the parents), and the differentiating marks of either parent appear in the hybrid. When elementary species are crossed the differentiating mark of one finds no mate to pair with in the other, and the hybrid does not embody all the features of both parents. The first case, following the terminology of McFarlane (1892) is a *bisexual cross,* the second, a *unisexual cross.* Unisexual unions show the diminution of fertility universally known as marking hybrids. Several examples are given.

Crosses between varieties (bisexual crosses) do not give rise to constant hybrids, but to hybrids that split in successive generations, usually according to the now well-known law of Mendel. Instances occur among clovers, snapdragons, violets, sugary varieties of corn with starchy varieties, *et cetera.*

The unit-characters "are represented in the hereditary substance of the cell nucleus by definite bodies of too small size to be seen, but constituting together the chromosomes. For these material bodies, deVries adopts Darwin's term of "*pangens.*" When a new elementary species arises it is recognized by the possession of a new unit character, which is the expression of the formation of a new pangen.

Ever-Sporting Varieties.—Accidental anomalies, however they may arise, are commonly called *sports.* Sporting is a constant character of some plants, and varieties "of pure and not hybrid origin, but which sport in nearly every generation," are termed *ever-sporting varieties.* Striped flowers, as the striped larkspur, are examples of this type. "Here the variability is a thing of absolute constancy, while the constancy consists in eternal changes!" Most of the so-called variable types in horticulture belong to this group. The variation is limited in extent by two extremes. Other examples than the striped varieties are fasciated branches, pitchers, split leaves, and peloric flowers.

Experiments were made with a snapdragon *Antirrhinum majus luteum rubro-striatum,* which has three types; (*a*) pure yellow, (*b*) pure red, (*c*) stripes of various width. There are no pure yellow racemes, but close inspection always reveals stripes. On the other hand the red flowers are a separate type within the striped variety, the gap between pure red and stripes never being wholly bridged over. The red type springs annually from the striped variety, and annually reverts to it, both through seeds and buds. This is sporting in the ordinary use of the term. Evidently the striped character must have been latent in the monochromatic form, but the latency is of a different type from that in Mendelian hybrids.

Five-leaved clovers show reversion to the more characteristic pinnate leaf of papillionaceous plants. They are distinct in nature from the four-leaved clovers, which usually are due merely to a splitting of one of the three leaflets of the ordinary type leaf. When a plant is poor in a variety, *e. g.*, only one or two four-leaved clovers on one individual plant, the anomaly is termed *a half-race*.

Pistillody in Poppies.—Pistillody, or the conversion of stamens into pistils, is often met with in poppies, the wall-flower (*Cheiranthus Cheiri*), the houseleek (*Sempervivum tectorum*), and other plants. Ovules borne by the altered organs mature good seed after fertilization, and plants from such seed inherit the anomaly of the parents, thus proving the hereditability of the peculiarity. Experiments show that the quality is possessed by distinct races only, and the cultivation of large numbers of the ordinary plants, in the hope of securing the anomaly, is useless. "Often pedigree-experiments lead to poor races, betraying their tendency to deviate only from time to time and in rare cases." These are the "half-races" already defined, as distinguished from the corresponding ever-sporting varieties, which sport in nearly every generation. The ever-sporting variety of the poppy has been cultivated for over half a century, and characteristically "fluctuates around an average type with half-filled crowns, going as far as possible in both directions, but never transgressing either limit." The *degree* of development of the anomaly varies directly with the individual strength of the plant, and therefore is affected by external conditions (especially amount of nourishment) from the time of fertilization onward.

But "no selection is adequate to produce either a pure strain or brightly crowned flower-heads without atavism, or to conduce to an absolute and permanent loss of the anomaly. . . . Limits are soon reached on both sides, and to transgress these seems impossible. Taking these limits as the mark of the variety, and considering all fluctuations between them as responses to external influences working during the life of the individual or governing the ripening of the seeds, we get a clear picture of a permanent ever-sporting type."

From the morphological standpoint monstrosities are accidents, but not so from the point of view of physiology. They even show that some hereditary quality, previously latent, has become active in response to external conditions. Here, also, under the same environment we may have poor races and rich ones, but each case has its limits, which are never transgressed through the influence of external conditions. All efforts so far experimentally to change a poor race into a rich one have failed, though the belief is expressed that "some time a method will be discovered of arbitrarily producing such conversions."

Andrews, E. F. *Botany All the Year Round.* 8vo. Pp. 302. American Book Co., New York. 1903.

A good book for the high-school, the product of evident thought and experience of a clever teacher. The "Practical Questions," in which attention is directed to economic matters, and "Field Work" constitute an especially useful feature. There is perhaps a little too much stress laid upon descriptive details, and not enough upon experimental work. The many illustrations are good, clear and diagrammatic.

Bergen, J. Y. *Elements of Botany.* 12mo. Pp. ix + 283 + 257 (*Flora of the Northern and Central States*). Ginn and Company, Boston and New York. 1904.

A revision of the well-known elementary text-book for the high school under the same title embodying some changes indicated by experience to be advisable. Although the cover is the least important part of a text-book we cannot withhold commendation of its very attractive design.

Bergen, J. Y. *Note-book to Accompany Bergen's Text-books of Botany.* 4to. Pp. 55—blank pages. Ginn and Company, Boston and New York.

This note-book consists of blank pages, for the record of experiments, at the tops of which are directions for the same. On page 3 there are some good directions for the pupil to guide him in the method of experimentation and of record. The whole thing savors of concession, regrettably unavoidable, to the mechanical adjustments in the handling of large classes. Whether the concession, if it be such, is in the right direction or not there will be difference of opinion. The size of the book makes it a bit clumsy and the paper is not quite good enough. Otherwise it is good in that it is as little formal as possible.

Grout, A. J. *Mosses with a Hand Lens.* Second Edition with Hepatics. 8vo. Pp. xiv + 208. $1.75. O. T. Louis Co., 59 Fifth Ave., N. Y. 1905.

A revised and enlarged edition of the author's earlier and very useful book, published in 1900, to which has been added a treatment of the liverworts of the same scope as that given to the mosses in the earlier edition. Amply and well illustrated, it does not assume any special knowledge, on the part of the student, and contains a good glossary. Determinations based upon characters obvious to the naked eye or under a good hand lens. The book will prove of help and stimulus to those who wish to begin the taxonomic study of the mosses and liverworts.

Overton, F. and Hill, Mary E. *Nature Study.* 12mo. Pp. 142. 40 c. American Book Company, New York. 1905.

A small volume planned for a year's work for higher grade pupils. Contains quite a number of practical suggestions, but these do not bear the stamp of newness in idea or method. The illustrations are with few exceptions of indifferent quality.

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THE EARLIEST LOCAL FLORA.*

BY EDWARD L. GREENE, LL.D.,
Associate in Botany, Smithsonian Institution.

This type of botanical book is one that, within the last century, has become very prevalent; the catalogue, descriptive or merely enumerative, of the vegetation of some limited area. Among such we have a few of the most instructive and fascinating of the books that deal with plant life and form, and besides these an exceedingly great number of the most inane. Among the writings of Linnaeus, the most classic and delightful, is his little local Flora of Lapland.

At the mention of this illustrious name, and of this particular book, several readers will infer that this is what is to be discussed under the caption of the Earliest Local Flora. Some may be aware of several others antedating this, and even quite pre-Linnaean. The one that I have in mind was done and published, and making for its author a deathless fame, considerably more than two centuries before Linnaeus was born. I refer to Thalius' "Catalogue of Trees, Shrubs and Herbaceous Plants of the Hartz Mountains," a small quarto of 134 pages, published at Frankfort-on-the-Main in the year 1588. The author calls it a "short catalogue" "containing an enumeration," etc.; a title-page so modest that, to read no further, one would not expect much.

The author was, in his time, a physician, in the practice of

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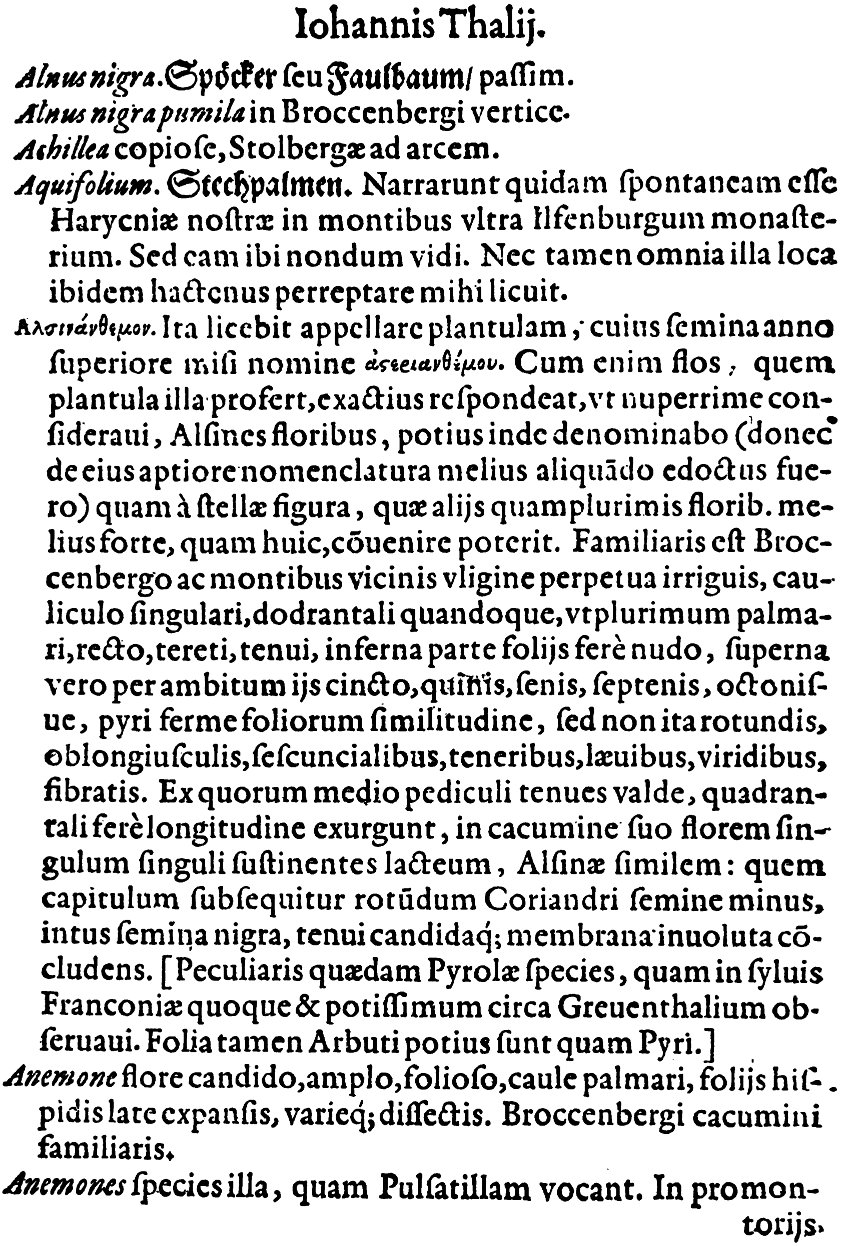
*Read before the Biological Society of Washington, 25 Feb., 1905. This is the second of a series of articles, to be published from time to time, on botanical matters of historic interest.



Iohannis Thalij.

Alnus nigra. Spöcker ſeu Faulbaum/ paſſim.

Alnus nigra pumila in Broccenbergi vertice.

Achillea copioſe, Stolbergæ ad arcem.

Aquifolium. Stechpalmen. Narrarunt quidam ſpontaneam eſſe Harycniæ noſtræ in montibus vltra Ilſenburgum monaſterium. Sed eam ibi nondum vidi. Nec tamen omnia illa loca ibidem hactenus perreptare mihi licuit.

Αλσινάνθεμον. Ita licebit appellare plantulam, cuius ſemina anno ſuperiore miſi nomine ἀστεριανθέμου. Cum enim flos, quem plantula illa profert, exactius reſpondeat, vt nuperrime conſideraui, Alſines floribus, potius inde denominabo (donec de eius aptiore nomenclatura melius aliquãdo edoctus fuero) quam à ſtellæ figura, quæ alijs quamplurimis florib. melius forte, quam huic, cõuenire poterit. Familiaris eſt Broccenbergo ac montibus vicinis vligine perpetua irriguis, cauliculo ſingulari, dodrantali quandoque, vt plurimum palmari, recto, tereti, tenui, inferna parte folijs ferè nudo, ſuperna vero per ambitum ijs cincto, quinis, ſenis, ſeptenis, octoniſue, pyri ferme foliorum ſimilitudine, ſed non ita rotundis, oblongiuſculis, ſeſcuncialibus, teneribus, læuibus, viridibus, fibratis. Ex quorum medio pediculi tenues valde, quadrantali ferè longitudine exurgunt, in cacumine ſuo florem ſingulum ſinguli ſuſtinentes lacteum, Alſinæ ſimilem: quem capitulum ſubſequitur rotũdum Coriandri ſemine minus, intus ſemina nigra, tenui candidaq́; membrana inuoluta cõcludens. [Peculiaris quædam Pyrolæ ſpecies, quam in ſyluis Franconiæ quoque & potiſſimum circa Greuenthalium obſeruaui. Folia tamen Arbuti potius ſunt quam Pyri.]

Anemone flore candido, amplo, folioſo, caule palmari, folijs hiſpidis late expanſis, varieq́; diſſectis. Broccenbergi cacumini familiaris.

Anemones ſpecies illa, quam Pulſatillam vocant. In promon-

torijs.

FIG. 26. A page from the "Sylva Harcynia" of Thalius.

medicine at Nordhausen; a man born and educated in the days when a boy too dull or indolent to face the difficulties of Latin and Greek grammar, and unwilling to devote a decade of his early life to the mastery of them, could never hope to obtain a college education or university degree, or rise to the practice of a profession.

No one has told us that this Dr. Johannes Thalius was very fond of botany, or that the happiest days of his life were those in which he found freedom to go away to the nearest mountain range to search for plants old and new; or that he was a great scholar in botany, familiar with every book about trees or shrubs or herbs that had ever been written, from Theophrastus, Dioscorides and Pliny down to his own contemporaries, Dodonaeus, Lobelius, Matthiolus, Cordus and Tragus and Gesner. Yet, in the simplest, most unostentatious manner, all this comes out in the "Sylva Harcynia," which is the shorter title of this small book of botany in Latin.

That he is not writing for the benefit of pharmacists or any other tradespeople, but only for the scientific botanist, is evinced by the method of the book; for, while using only the Greek or Latin names of genera, he defines no genus, except such as he finds new and in need of a name. He treats of the species all in the alphabetic order of the generic names. His book has no index, and needs none. Only botanists, persons who know the genera of plants and the scientific names of them, are going to care about the book, anyway.

By the alphabetic order, the genus *Adiantum* is the first, naturally. He catalogues four species, namely, *A. pulcherrimum, A. candidum, A. aphyllum* and *A. achrosticum;* binary names, of course, but that is hardly noteworthy. It is the natural nomenclature everywhere, in all ages, by all authors, especially in all departments of nature study. Well, he has so much to say about these four *Adiantums* that the genus fills the initial page of the catalogue. The first species listed, *A. pulcherrimum,* he describes fully, and this evidently in order that others who may in the future go botanizing in the Hartz Mountains may be on the lookout for this plant, and may also have the means of determining it when they find it, for he says: " I myself have not yet found it there, but I have it in a book, glued down to a sheet of paper, which I came upon some years ago in a drug store in Nordhausen, whither it had been brought from Harcynia by an old woman who had gathered herbs there." Here we have then the true scientist of the most faithful and philosophic stamp, putting future students of the Harcynian flora on the watch for a rare plant which he confesses he has been unable to find there himself, yet stating minutely the singular circumstances under which he became convinced that it really does grow there.

Reading on after *Adiantum,* in the order of the letter A as initial, we find on every page things keenly interesting, especially provided we know the early history of common plants well enough to comprehend what Thalius' single and binary, or often ternary, names stand for in present day binary nomenclature. On page seven are listed three species of *Aconitum,* called by him *A. caeruleum, A. lycoctonon* and *A. Matthioli.* In current usage as to names, the first is *A. Napellus,* the second *A. Lycoctonum,* the third *Eranthis hyemalis* Salisb., or *Cammarum hyemale* Greene, as you like; in English, Winter Hellebore. This elegant little plant with the solitary yellow corolla of a buttercup or marsh marigold would never by any novice, whether of the twentieth century or of the sixteenth, be associated in the same genus with the monkshood. The smatterer, the superficial observer in any age or epoch would place this plant as a *Ranunculus* or a *Caltha;* and that perfectly regular yellow perianth regarded alone, and without reference to other details of structure, is what would have betrayed the tyro into such an error. But the skillful botanists of three centuries ago, if not indeed also of three thousand, always associated it with *Aconitum,* because, after the falling away of the perianth, and the development of the pods, the whole plant,—root, leaves and seed-pods—looks like a dwarfed and one-flowered monkshood, rather than even like a hellebore. And this proved to real botanists centuries ago that here lay the little winter beauty's real affinity. Even the generic name *Cammarum,* under which the present writer has lately placed it, is only an ancient Greek synonym of the monkshood or *Aconitum.* Thalius and his predecessors and contemporaries were simply a little too conservative in their ideas of the limits of a genus, or they would have segregated this from *Aconitum* as a good genus; a proposition which came, at length, from Boerhaave at the time when Linnaeus was a very small boy.

A little further on two pages are devoted to listing and describing the Harcynian species of *Alsine;* a name that was as good as lost to botany during the nineteenth century, but which has now got back again into use instead of that interloping name *Stellaria.* Of the five binary names for *Alsine* species, the second is *A. media,* a name of late grown familiar again. It is now, however, attributed to Linnaeus, who was of a later date by more than a century and a half, and who himself never claimed it as other than an adopted name from earlier authors.

Page fifteen of the catalogue is occupied almost wholly by the description of a new genus; and I have a vivid recollection of the thrill of pleasure I experienced, now a dozen or fifteen years since, when I first read the paragraph descriptive of his new genus *Alsinanthemum,* and saw clearly by the first reading that this could be no other than what we know as *Trientalis.* The account he gives of this little denizen of moist shades, with its slender stem a span high, with leaves mostly near the summit, from amid which rise several very slender pedicels each bearing a milk-white star-shaped flower, these succeeded by capsules of the size of a coriander or smaller, each with several black seeds enveloped in a membranous inner covering,—and his remark that in a former year he had sent a botanical friend seeds of it as those of a new genus which he had then proposed to call *Asterianthemum* in allusion to its perfectly star-shaped corolla—all the page pictured, not only one of my favorite plants most lucidly, but also told the story of long experience of careful and scholarly study on the part of that writer, and his ability to create a diagnostic representation of a plant, without trace of that pedantic formalism now grown so common as to be often considered indispensable to descriptive botany.

The book contains a considerable number of species, described as new, as well as three or four other genera beside *Trientalis.*

Of these I wish to advert to at least one more, and one which shows that this botanist, when afield, both observed and minutely described the smallest and most insignificant of flowering plants, such as other able and learned botanists before him either had not seen, or else had not thought it worth while to name and describe. Thalius was the first to study and describe as forming a new genus that group of plants now known as the genus *Eleocharis,* commonly believed to have been first segregated from the old *Scirpus* aggregate by Robert Brown in 1810, which Thalius' *Lychnanthemum* therefore antedates by two hundred and twenty-three years.

It is very interesting to observe the skill with which this botanical scholar and expert accomplishes his task of trying to convey to the minds of his readers an idea of what an *Eleocharis* looks like. It must be borne in mind that a man drawing up descriptions of new genera and new species as long ago as the years, we will say 1570 to 1585, had few models before him for imitation. That adjunct of phytography, a fixed descriptive terminology evolved much later, was not available to writers of the sixteenth century. But one thing a respectable botanist of any era must do: he must describe plants in such a way that any competent botanist reading the description may thereby form a mental picture of the type described. And this thing Thalius had to accomplish on the strength of his own resources, as a man of cultivated intellect and of botanical experience. His descriptions are, therefore, wholly original; framed upon his own model. Here is his account of the genus, simply turned into English.

" *Lycnanthemum* consists of erect rush stems each bearing at its very apex a spicate flower, the outline of the whole recalling a candle and its flame. Of this genus I have observed at least three species. A large one has large stalks or rushes, and rather thick, of about the thickness and figure of a wheat-straw, the spicate apex, which takes the place of a flower, being yellowish brown, two inches long, and appearing to be made up of compacted chaffy scales. A middle sized species consists of reeds much more slender and not sustaining themselves in that erectness, their height little more than the width of one's palm, ending in a short spike, hardly an inch long, of a chestnut brown. This may be called *Lycnanthemum tenue major.* It is common on the Brocken Mountain. There is a third, which I name *Lycnanthemum tenue.* This sends up many short rush stems, only a finger high, with a very small spike approaching chestnut brown in color. I have seen this nowhere but on the Brocken."

The description of the first of these three *Lycnanthemum* species is answered by no other plant of the Brocken but *Eleocharis palustris.* The diagnosis of *L. tenue* is more brief, though not less decisive of another member of the genus. I tried once the reading of this diagnosis to a botanist who is facile with his pencil, to see what he would make of it. As soon as the drawing was done I asked, " Now what have you? " and he answered promptly, "*Eleocharis acicularis,*" and the answer cannot be gainsaid.

Local floras at once adorned with scholarship, bright with vivid pen-pictures of living things, and redolent of woodland and of field, are rare in every age; and this fine old classic by Thalius is one of the most charming of all the books that answer that description.

THE GAS PLANT.

By Professor W. J. Beal,
Agricultural College, Michigan.

The gas plant is an herbaceous perennial of the Rue family (Rutaceae), known technically as *Dictamnus albus* L. (*D. Fraxinella* Pers.). It exhales a vapor which is inflammable—thus justifying its name " gas plant."

The pistil is compound, deeply lobed, consisting of five carpels, each containing 2–3 seeds, " each carpel, when ripe, splitting into 2 valves," which divide into an outer and an inner layer. In other words, when mature, a considerable portion of the endocarp separates from the exocarp, and at once each half begins to make the attempt to twist in an opposite direction, much in the manner of the ripe half-carpels of a vetch or pea. In this operation, the half-endocarps press the apical portion of the carpel wide open (Fig. 27, E). A slight ridge on the inner edge of each margin of the carpel prevents for a time the escape of the twisting endocarp. The placenta separates, forming another, thin trough-like piece (Fig. 27, C), the margins of which are inside of the endocarp. The two seeds separate from the placenta which sets loosely over the seeds, preventing them from falling out in case the branch bends down toward the ground. Seeds are torn off the placenta as this dries, shrinking away in the central portion and lastly at the ends, which approach each other slightly.

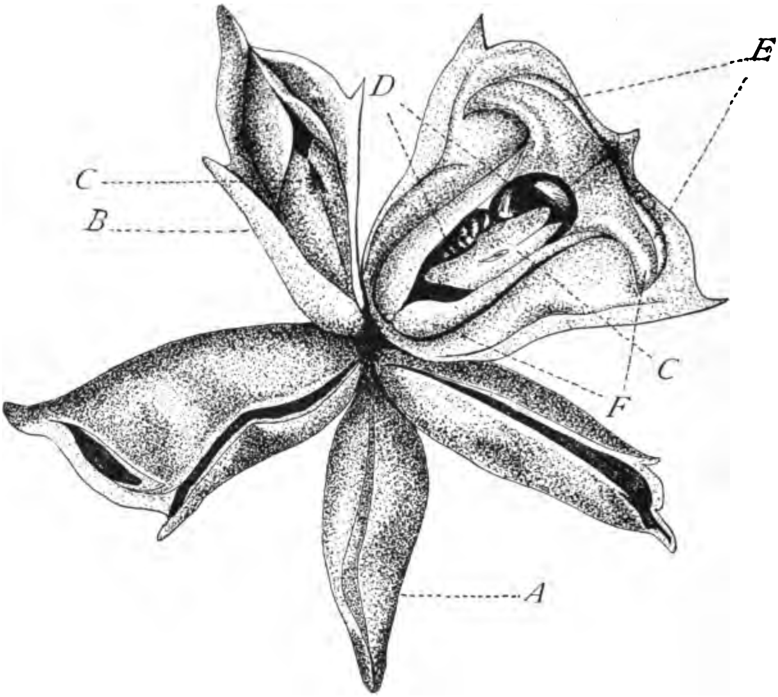


Fig. 27. Entire pistil of *Dictamnus albus*. *a,* carpel closed; *b,* carpel beginning to open; *c,* thin placenta freed from rest of carpel and seeds; *d,* two seeds partially covered by placenta; *e,* margins of free endocarp, spreading exocarp open; *f,* extremities of one-half endocarp.

Each half-endocarp resembles in a general way a capital letter J (Fig. 27, E). The apical portion of the endocarp presses outward, while the basal portion tends to twist inward. When dry enough, and the carpel spread open well, if the stems are jarred against each other by wind or animal, or the carpel presses laterally or from each extremity, a sharp explosion follows as the half-endocarps complete their twisting, thus liberating the thin placenta and throwing out the seeds. When left to themselves in a quiet place where there is no artificial pressure, the tension of the endocarp at length forces its way out, sometimes sending one or both seeds as far as seventeen feet, possibly in some cases aided somewhat by the wind. The black, smooth seeds are nearly the shape of a pear which is spherical with a short neck. The seed is nearly 45 mm. long, by 3 mm. or more in transverse diameter. In size they are much like those of *Vicia sativa*.

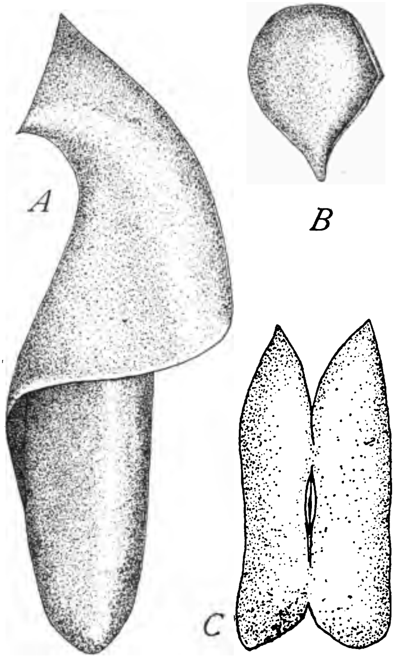


Fig. 28. *A,* half of endocarp, enlarged, to show its twisted form after leaving carpel; *B,* seed enlarged; *C,* placenta enlarged.

THE "MONSOON-DUST" OF THE SOUTH ATLANTIC OCEAN.

The term monsoon is not restricted to the periodic winds of the Indian Ocean, but is often applied also to a similar wind that blows over the Atlantic Ocean between the coast of Brazil and the west coast of Africa. Sailors plying these waters at the time of this monsoon are familiar with the phenomenon known as the "Monsoon-dust," or "*Passatstaub.*" There appears over the ocean surface a color quite different from the usual ocean hue. In quiet weather the surface of the water in the distance, and often in streaks, appears to be of a peculiar yellowish or yellow-green tint.

This variation in color from the usual blue-green of the sea in quiet weather is quickly recognized by even the "land lubbers," and has been for a long time a familiar sight to sailors.

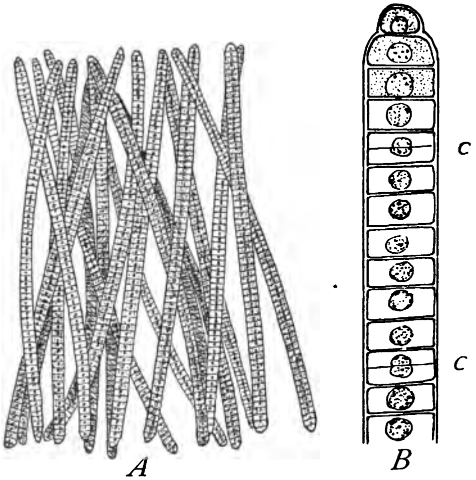


FIG. 29. *A,* a complete colony of *Trichodesmium Hildebrantii* forma *Atlantica; B,* part of a single filament showing the smaller cell at the end at *a* and *a* cells which have just divided. (After P. R. Reinsch.)

It has been the general opinion that the periodic variation in color is due to some pigmented substance floating on the water surface, because with the lightest wind the color effect is destroyed, and therefore cannot be due to any peculiarity of the water itself.

Hitherto it has been generally held in explanation of the phenomena that the monsoon wind at the time of this peculiar appearance, blowing over the long stretch of forest along the Brazilian coast becomes laden with pollen, especially that of the *Abietineae.* When the pollen-laden breezes blow over the ocean the pollen falls upon the surface. So, during the pollen season, the ocean surface would owe its strange color to floating pollen grains.

This explanation has recently been shown to be quite erroneous. Reinsch, from whose paper in *Flora* this note is in part a rather literal transcription, has examined samples of water taken off the coast of Brazil (Lat. 19.34° S., Long. 38.58° W.) from water that showed the peculiar color. These samples were found to contain quantities of one of the Oscillariaceae, belonging to the genus *Trichodesmium,* established by Ehrenberg. Three different species occur floating on the surface of different oceans. Accumulating in endless mass they give rise to the phenomenon known as "sea blossoms" (*Seeblüte*). The color varies from purple-red to brownish yellow and yellowish green. The material examined by Reinsch was classified as *Trichodesmium Hildebrantii* Gom. *forma Atlantica.*

Ehrenberg* in 1830 described a similar coloring of the sea in the Gulf of Sinai, and attributed the phenomenon to the presence of these algae.

There is also recalled in this connection the "flowering" of some of the Adirondack lakes, described by Howe,† and due to the presence on the water surface of quantities of *Gloiotrichia echinulata.*

The "water bloom" of some of the glacial lakes of Minnesota is also attributed by Nelson‡ to the presence of algae.

C. S. G.

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* Ehrenberg, Annalen der Phys. und Chemie, **18**: 506. 1830.

† Howe, Marshall A., A note on the "flowering" of the lakes in the Adirondacks. Torreya, 3: 150. 1903.

‡ Nelson, A. P. B., Observations upon some algae which cause "water-bloom." Minn. Bot. Studies, 3: 51. 1903.

THE CHIMNEY-SHAPED STOMATA OF THE BURRO THORN.

Dr. C. E. Bessey describes in the *Bulletin of the Torrey Botanical Club,* October, 1904,* a peculiar plant—the "burro thorn" which was collected some years ago by Mrs. Dorothy Bacon in the Salt River Valley near Phoenix, Arizona. This shrub at once attracts attention because of its complete leaflessness, and the thorny nature of its branches. It is said to grow about 10 feet high, and to form an impenetrable thicket from the ground up. It grows in the desert where it was first found about fifty years ago by Major Emory of the U. S. Army on one of his expeditions.

The plant is locally known as "burro thorn," "sacred thorn," "crucifixion thorn," and by the Mexicans as "crucifixo" and "corona de Cristo." Sometimes people in the locality where it grows have called it in pseudo-scientific fashion "*Crucifera spinosa*" under the impression that it is a good botanical name.

Although it is usually a low, spreading, much branched shrub, it attains in the plains south of Maricopa, Arizona, to the size and habit of a small tree.

Seedling plants bear small leaves, but the mature plant is leafless, nothing more than the smallest scales remaining as vestiges. The branches have become modified into spreading thorns, which are themselves freely branched again.

"All parts of the surfaces of the branches and thorns are of a pea-green color, and minutely roughish to the touch. Upon making a transverse section the epidermis is found to be of unusual thickness, being no less than three, four or five layers of cells deep. The outer wall is of excessive thickness, and those below, while much thinner, are still very thick. The lateral walls, also, are greatly thickened, so that in a superficial view the cell-cavities are widely separated. Microchemical tests show that the outer epidermal cell-walls are strongly cuticularized, while those below are less so, or not all. Below the epidermis lies a thick mass of palisade cells (*p*), abundantly supplied with chlorophyll. These cells are closely packed in about three layers, the cells averaging from three to four times as long as their diameter. In this palisade mass there occur at frequent intervals large crystal-cells, each containing one large clustered crystal (*c*). The tissue beneath the palisade cells is thick walled (*h*), but the walls are not cuticularized, the stain reaction being that characteristic of cellulose.

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*Bull T. B. C., 31: 9. Oct., 1904.

The stomata are thickly scattered over the surface of the stems and thorns, a careful count showing that they number about seventy-three per square millimeter. Each stoma lies at the bot-

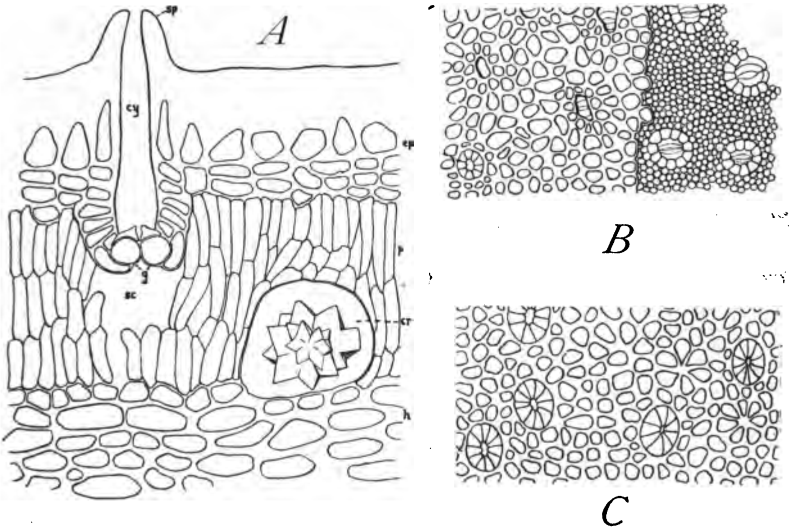

FIG. 30. *A,* part of a transverse section of a twig; *B,* section parallel to surface and near to the palisade tissue (seen at the right); *C,* a similar section near to the cuticle.

tom of a narrow chimney-shaped cavity (*cy*) which passes entirely through the thickness of the epidermis and is prolonged both above and below it. This stomal channel is thus of greater length than the thickness of the epidermis.

Cross-sections of the stomal cavity (chimney) show that at its outer end it is round or elliptical, and of somewhat smaller diameter than elsewhere. Below the top of the chimney the cavity is round, elliptical, ovate, or irregularly oblong in section (*cy*). The walls of the chimney are composed of about eight vertical rows of cells (*B, C*), whose boundaries may be faintly seen in the stomal papilla in preparations mounted for some time in glycerine. These vertical rows appear to be continuous down to the proper stomal apparatus at the bottom of the chimney. They become much more distinct as they pass inward.

The stomal apparatus at the lower end of the chimney consists of from forty to sixty or more cells which extend down into the mass of palisade tissue some distance, thus prolonging the chimney. A cross section of this stomal apparatus shows it to be almost perfectly circular, or slightly elliptical, and to consist of from ten to twelve rows of thinner-walled cells than those which form the main portion of the chimney above. At the bottom of this structure is the proper stoma (*B*). It closely resembles the stomata of ordinary plants. The guard-cells are thick and large, and in cross-section are nearly circular. Each is provided with a projecting ridge on its upper surface, and these by approximating form a small "front cavity," the "back cavity" being entirely absent.

Beneath the stoma is the usual air-cavity (*sc*) which is lined with irregular and loosely bordered palisade cells. The intercellular spaces in the mass of palisade tissue are very small.

We have in this extraordinary structure a most effective device for protecting the plant against loss of water, while at the same time permitting free access of gases. The highly translucent epidermis admits light while its high degree of cuticularization prevents loss of water. It would be difficult to imagine a structure with a more perfect adaptation to existence under conditions extremely trying to most forms of vegetation." M. E. H. L.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

MOULDS AS THE CAUSE OF DISEASE.—The fact that bacteria are the causes of many diseases is generally known to the public; the classification of bacteria as plants and not as animals is less widely recognized, and the association of other and more highly organized plants with pathological conditions is probably known only to a few specialists. Such fungi have, however, been identified with certain diseases in man and other animals and form an interesting chapter in the economic importance of fungi.

There are relatively few such pathogenic fungi and most of them are species of the mould *Aspergillus,* though species of *Mucor* and other Phycomycetes have also been identified. The parts of the animal body most frequently affected are the mouth and respiratory apparatus, the eye, ear, skin and some of the internal organs. The most common disease is probably what is known as pulmonary mycosis, or a disease of the air passages and pulmonary tissues resembling tuberculosis. When this is caused by an *Aspergillus* the disease is termed aspergillosis. The first case of aspergillosis was observed as early as 1815 in the lungs of a jay, and in 1847 was reported an instance of its occurrence in man. Cattle, sheep, horses and dogs have also been the victims of mycotic troubles but the animals which seem to be peculiarly subject to them are birds, especially those living in a state of captivity in zoölogical parks.

Aspergillosis in man was observed at first in connection with tuberculosis and was regarded as a secondary occurrence and not of particular importance. It was later studied, however, very thoroughly as it occurs in a certain class of men in Paris. These men are engaged in feeding thousands of young pigeons daily by taking into their own mouths a mixture of grain and water which they force down the throats of the young birds, much in the way it is done by the old birds. It was discovered that these men suffered frequently from a pulmonary disease which was supposed to be tuberculosis until an examination was made and the spores and mycelia of *Aspergillus fumigatus* were found to be present in the lungs. Infection, it was decided, took place through inhaling spores present in the grain. There was apparently no trace of the tubercle bacillus.

Inhalation of the spores seems, in fact, to be the usual way of acquiring the disease. The spores planted thus on the bronchial mucosa germinate, mature and produce fruit. These spores are then distributed through the bronchioles and even into the air sacs of birds. The food required for these processes is obtained from the tissues of the host. It has been claimed by some investigators that a dangerous toxin is produced by the fungus during growth. Their work, however, has not been confirmed and it is generally believed that mechanical irritation alone serves to account for the harm done by the fungus. The temperature of the human body and the still higher temperature of birds seem to be peculiarly adapted to the growth of *Aspergillus fumigatus* though most of the other fungi grow best at a lower temperature. The moisture and plentiful supply of oxygen present in the lungs and air passages furnish excellent conditions for luxuriant growth.

In America very few cases of aspergillosis have been reported, only three or four in man and several in birds. One of the latter was investigated recently by Mohler and Buckley of the Government Bureau of Animal Industry.* Their subject was a flamingo which had been captured in Cuba, was brought to the National Zoölogical Park in Washington and died within three weeks. A post-mortem examination showed the lungs covered with grayish spots and the supra-sternal air-sacs were lined with a velvety green growth which proved to consist of masses of mycelia and fruiting heads of *Aspergillus fumigatus.* This fungus is a typical *Aspergillus,* having a branched septate mycelium, white at first, later green and gradually turning to brown. The spores are cut off in chains from the ends of short knobs which radiate from the surface of a globular head. The spores are spherical and colorless, and are capable in a dried condition of retaining their vitality for many months and even years. In order to determine the amount of harm which may be done by the fungus, the investigators experimented with a number of animals, chickens, pigeons, guinea-pigs and rabbits, inoculating them with spores of *Aspergillus.* In the majority of cases death resulted although a few animals seemed able to resist the attacks of the fungus and survived.

A short summary of various studies made of aspergillosis is given by the authors just mentioned: (1) Aspergillosis is a spontaneous disease affecting the bronchi and lungs of birds and mammals. (2) The disease may be transmitted experimentally. The botanical and cultural characteristics of the fungus are specific. In its pathogenic action it resembles the tubercle bacillus. (3) In man it develops on the skin but particularly in the respiratory apparatus, creating pulmonary mycosis resembling tuberculosis. It may co-exist with tuberculosis. (4) It is not a simple saprophyte but a true parasite. A. W.

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* Mohler, J. R. and Buckley, J. S., Pulmonary mycosis of birds. U. S. Dept. Agric., Bureau of An. Ind., Annual Report, 20: 122–138. 1903.

NOTES ON REGENERATION.—The *Begonia* and the various members of the house-leek family have become almost classic material for the illustration of regeneration, but many other plants demonstrate the same principle quite as well. If the petiole of a *Gloxinia* leaf be imbedded in sand the base thickens into a tuber, while if a leaf of the wax plant (*Hoya*) be placed in sand in the same way, fibrous roots arise from it, showing that hereditary characters are regenerated in each case.

The flower cluster of a *Geranium* may produce a shoot bud. In such a cutting made by me a bud had previously appeared in the midst of the flower cluster which was then plucked from the parent plant and placed in the soil. This bud grew into a leafy shoot and produced a new flower cluster, while the faded blossoms of the original inflorescence were still clinging to their stalk. This also produced a shoot-bud among its flowers. The original flower-stalk increased very little in size and after about six months was accidentally broken off. This was planted and is still growing vigorously. W. J. R.

ARE THE ANTHERS of the Compositae fused together during growth or are they merely adherent through the agency of some adhesive material such as gum, resin or wax, is a question which has been raised and appears to have been answered satisfactorily by A. Tschirch.* He used freehand sections of material which had been hardened in alcohol. These were mounted on a slide in a strong solution of Sudan in a fluid made up of one part alcohol and one part of glycerin. After remaining twenty-four hours the stain was removed, without moving the cover glass, with alcohol and water, and pure glycerin was added for preservation. The cuticle is then bright red, the remaining tissues remaining uncolored. The conclusion attained is that the anthers are neither adherent merely nor are they grown together in the usual meaning of the expression, but the cuticle only of adjacent anthers becomes grown together for a little distance and remains so. There is thus formed a cuticular ligament or short tube which completely surrounds the five anthers from which it is derived, but in which they are free. The secondarily exposed surfaces of the anthers do not become cuticularized. When the anthers are ripe and spring open, the common cuticular investment is loose from the outer surfaces of the anthers. That of the inner faces however remains still attached to the walls of the anthers. F. E. L.

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* Flora, 93: 51. 2 Nov., 1904.

BY GROWING GRAPE VINES under proper control in situations so that the wind could play upon them for a total growing season, A. Heller* has shown that the leaves suffered in becoming brown about the edges. By the end of June those leaves which were almost constantly moved by the wind began to show a brown discoloration of the single teeth and of portions of the edge, and a month later numerous leaves showed this discoloration throughout the whole extent of the margin. The leaves hardly ever suffered any wilting in the sound parts, these remaining so till the end of the autumn, since the damage done by the relatively weak winds made advances only slowly. On the islands of the North Sea on the other hand the damage spreads to the whole leaf. The damage thus caused has been variously attributed to the temperature of the wind or the salt or sand carried by it. The point raised by Hansen has important bearings on the explanations given for the damage or destruction of vegetation in regions where the climate is unfavorable to it, as well as in places where the vegetation is supposed to have been harmed by the smoke from factories. It will hereafter be necessary to analyze the problem more closely so as to determine what damage may have been caused by the wind alone and what by the possible materials carried by the wind which are harmful to plants. F. E. L.

"A REMARKABLE INSTANCE of what the author thinks may be true mimicry in plants is described by Dr. R. Marloth.* Years ago it appears that the traveler Burchell picked up on stony ground an object he mistook for a pebble, but which on examination proved to be a plant of the genus *Mesembryanthemum*. Both in color and in form this plant, previously named *M. truncatum*, presented a remarkable resemblance to the stones among which it grew. A second species, *M. bolusi*, growing on the hills around the Karru, generally produces two leaves about the size of a duck's egg, which have a surface like weathered stone, and a brownish gray color tinged with green. In this state it closely resembles the surrounding stone, although for a short time its bright yellow flowers render it conspicuous enough. *M. nobile* is very similar. A fourth species of the same genus, together with *Anacampseros papyracea* (in which the leaves are covered with white papery stipules) resembles the quartz pebbles among which it grows. In the author's opinion *M. bolusi*, *M. nobile*, and perhaps *M. truncatum* (which, unlike some of the other plants mentioned, do not change their characters under cultivation) may afford instances of true mimicry."†

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*Flora, 93 : 32. 1903.

*Trans. So. Af. Phil. Soc., 15 : 97.

A CURIOUS and apparently quite useless physiological behavior of the scission layer in the sweet-gum (*Liquidambar styraciflua*) is worth drawing attention to. In other trees and sometimes in this one, the activity of the scission layer terminates when its function is completed, that is, then, with leaf fall. In the tree which I have in mind the growth of this layer continues during the succeeding seasons in such a manner that a curved column of cork is formed of the length of a half centimeter or more. At the top of the column, which is directed distally, the original leaf-scar can be seen, and some trace of the influence of the vascular tissues may be detected in the cork on sectioning. The cork columns remain discrete for two or three years usually after which they may be more or less disguised by the cork wings (characteristic of this plant) which are formed and which, by anastomosis, finally quite hide the original condition. F. E. L.

THE SO-CALLED UNIFOLIATE species of *Streptocarpus* are unusual in their morphology. According to Fritsch,* who confirms the earlier studies of Dickson, the two cotyledons are separated by an internode. One of these remains very small, while the other develops into a large foliage leaf which lies prostrate. Beyond the cotyledons the chief axis does not develop. What appears to be the chief axis is the stem of the inflorescence which arises from a bud in the axil of the larger cotyledon. F. E. L.

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† Nature, 71 : 232. 5 Jan., 1905.

* Die Keimpflanzen der Gesneriaceen. Jena, 1904.

ANNOUNCEMENT OF FIELD SYMPOSIUM.

The second annual field symposium of botanists will be held during the week beginning July 3, 1905, at Ohio Pyle, a point on the Baltimore and Ohio Railroad in Fayette County, southwestern Pennsylvania, where arrangements have been made for the accommodation of the party. Information concerning details of the trip and the proposed program may be obtained from Mr. Joseph Crawford, 2824 Frankford Avenue, Philadelphia, representing the Philadelphia Botanical Club, from Dr. J. A. Shafer, New York Botanical Garden, Bronx Park, New York City, representing the Torrey Botanical Club, or from Dr. J. N. Rose, U. S. National Museum, Washington, D. C., representing the Washington Botanical Club. The pleasant and profitable experiences gained by those who attended the first of these meetings, held at McCall's Ferry, Pennsylvania, in July, 1904, give reason to believe that there will be a large attendance at Ohio Pyle. A detailed report of the proceedings at McCall's Ferry will be found in the February issue of the Plant World.

REVIEWS.

Species and Varieties: Their Origin by Mutation.*

III.

Monstrosities.—As examples of monstrosities are mentioned the twisted stems in the wild valerian (*V. officinalis*) and the fuller's teasels (*Dipsacus fullonum*) and other plants. In the case of the wild teasel (*D. sylvestris*) a rich race was secured through experimental cultures. Success depends, first, upon finding a rich race, second, upon treatment (good soil, water supply, room, etc.), and "very little on selection." Atavists occur in this race as in the polycephalous poppies, with intermediate gradations between them and the wholly twisted variety, but, as in the case of the striped flowers of the snapdragon, the series of gradations between the atavists and the type of the race is never complete. The gap is never entirely bridged over.

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* Species and Varieties: Their Origin by Mutation. Hugo de Vries, edited by D. T. MacDougal. Chicago: The Open Court Pub. Co. 1905.

The character of twisted stem is not a variation in the ordinary sense of the term. "It is more a contention of opposite characters," and we have here an instance of a "double race, including two types which may be combined in different degrees."

The percentage of cases in which the varietal attribute is transmitted is more important than the degree to which it may be possessed by a few individuals. This proportion is the *hereditary percentage*.

Double Adaptations.—An instance of ever-sporting varieties is represented in those species which have double adaptations, *e. g.*, the water persicaria (*Polygonum amphibium*). The terrestrial form (var. *terrestris*) and the aquatic form (var. *natans*) readily sport into each other, and the change may even be brought about artificially by transplanting one into the environment of the other. Branches of the same plant have even in some cases been described by systematists as different species. The climbing fig (*Ficus repens*), which bears no fruit, and the fruiting shrub (*F. stipulata*) "are simply branches of the same plant." Bonnier divided an alpine plant and transferred one half, with plenty of mountain soil, to the valley at Paris. The difference in environment made enough difference in the two halves to stamp them as varieties.

Double adaptation is universal in the whole plant kingdom, *e. g.*, the response to light and darkness. In ever-sporting varieties two types are always present, but one is apt to be useful to the plant, another less so and possibly injurious. Thus natural selection which seizes upon only useful characters, will usually perpetuate only one type. This explains why we do not have, for example, a pure and common race of twisted teasels.

Monstrosities and dimorphous wild species offer the most striking examples of the inheritance of latent characters. It is instructive to consider in the light of Lamarck's theory the direct effect of external influences on organisms in producing new species. If environment results only in certain characters becoming latent, they may resume activity even after thousands of years of latency, and thus no change of specific value is wrought by the direct influence of environment. This conclusion is confirmed by Haltermann's experiments, showing that desert characters possessed for centuries disappear easily and quickly when the plants are grown in the garden in the absence of their desert environment.

MUTATIONS.

The preceding discussion has brought out the idea of unit-forms, sharply delimited, each type manifesting fluctuating variability between extremes. Extremes of different types may often overlap, but their offspring always return to the type. These unit-forms, the elementary species and varieties, are discontinuous. The gap which separates them is never bridged. Units may die out, leaving the gaps between neighboring units still wider. The problem of the mode of origin of species resolves itself into the question of how elementary species and varieties originate. Organic nature has not reached the end of its development and the origin of species may be observed in the origin of elementary species and varieties. The method of experimentation is also available. The idea of enormous time requirements demanded by Darwin's hypothesis may now be discarded. The chief requisite is to "try to arrange things so as to be present at the time when nature produces another of these rare changes."

The Origin of the Peloric Toad-flax (*Linaria vulgaris peloria*).—Pelories are sometimes produced at the base of the raceme of the common variety (*L. vulgaris*), but the peloric variety bears only peloric flowers, and the form may originate independently in different localities, and since the peloric form is barren, there must be as many mutations as localities. In the experiment the mutation sought for was observed only after eight years of work, and this is the first experimental mutation of a normal into a peloric race. "The mutation took place at once. . . . No intermediate steps were observed. . . . There was . . . no visible preparation for the sudden leap. . . . No reminiscence of the former condition remained. . . . Not a single flower on the mutated plant reverted to the previous type. . . . The whole plant departed absolutely from the old type of its ancestors." The numerical proportion of the mutation was only 1% of the whole crop of 1,750 flowering plants. This emphasizes the need of cultivating large groups of plants in experimental work. The experiment was repeated, showing the iterative nature of mutation.

In the second generation, 90% of the pelories inherited the pelorism. The 10% reverting were doubtless either atavists or vicinists.

The snapdragon (*Antirrhinum majus*) produces peloric races in the same way as does the toad-flax. The most widespread peloric variety is that of *Gloxinia,* and several other plants are mentioned that produce peloric flowers. Some families are more liable to pelorism than others. Here is a rich field for further studies of experimental mutation.

The Production of Double Flowers.—The historical facts concerning the origination of double varieties justified the attempt to obtain them experimentally. A species was chosen which had not been known previously to produce a double variety, and success was enhanced by the choice of a plant the nearest relatives of which are known to have produced double flowers. Such a plant was the corn-marigold (*Chrysanthemum segetum*), having tubular disc flowers and an average of 13 ray flowers. The variety *grandiflorum* has an average of 21 ray florets, and from this the double variety was finally produced. Out of 1,500 plants 500 were chosen having 21 or more rays, but only two heads had as many as 22, and these on one plant. The index of doubling in the composites is not the increase in number of marginal ray florets, but the conversion of tubular disc florets into rays. Up to the fourth generation this character did not appear, when it suddenly manifested itself in 3 heads. The appearance was not gradual so far as any outward indications show. It was an abrupt leap. Whether the mutation took place four years back in the first generation, and laid dormant for four years, or whether it developed gradually through the four generations, suddenly to appear in the fourth, or whether the entire change was accomplished in the individual, where it was first manifest, it is difficult to say. The experiment was begun in 1896 and in 1901 the number of rays had increased from 21 to the maximum of 200, or to complete doubling.

The race is constant and no atavists or reversionists have appeared since the first purification of the race, though fluctuating variability occurs. The new variety is termed *plenum*. All the offspring of the parent that first showed the mutation manifested the new character with but a single exception in any blossom, and deVries thinks the inner change thus manifest took place within the plant of the fourth generation.

SUMMER COURSES IN BOTANY.

For the benefit of teachers who are contemplating summer study, we give below a list of courses offered at various institutions during the coming summer, announcements of which have been received.

THE UNIVERSITY OF CHICAGO. First Term, June 17 to July 27. Second Term, July 28 to September 1.

STAFF: Professor John M. Coulter, Assistant Professor B. M. Davis, Dr. Charles J. Chamberlain, Dr. H. C. Cowles, Dr. W. J. G. Land, Dr. W. B. McCallum, Dr. E. N. Transeau, Dr. F. M. Lyon, Miss Tarrant.

COURSES: *Advanced Morphology,* Professor Coulter, Dr. Chamberlain. *Research in Morphology,* Professor Coulter, Dr. Chamberlain. *Special Morphology of Angiosperms,* Professor Coulter, Dr. Chamberlain. *General Morphology of Spermatophytes,* Professor Coulter, Dr. Land. *Special Morphology of Algae,* Assistant Professor Davis. *Cytology,* Dr. Chamberlain. *Field Ecology,* Dr. Cowles, *Elementary Botany,* Dr. Lyon. *General Morphology of Bryophytes and Pteridophytes,* Dr. Lyon. *Methods in Plant Histology,* Dr. Land. *Field Botany,* Dr. Land, Miss Tarrant. *Elementary Plant Physiology,* Dr. McCallum. *Elementary Ecology,* Dr. Transeau.

CORNELL UNIVERSITY. July 5 to August 16.

STAFF: Assistant Professor W. N. Rowlee, Dr. E. J. Durand, Miss E. M. Cipperly.

COURSES: *Elementary Plant Physiology and Morphology,* Dr. Durand, Miss Cipperly. *Special Morphology and Ecology of the Higher Plants,* Assistant Professor Rowlee, Miss Cipperly. *Taxonomy and Embryology,* Dr. Durand. *Trees and Shrubs,* Assistant Professor Rowlee.

HARVARD UNIVERSITY. July 5 to August 15.

STAFF: Dr. Robert Greenleaf Leavitt, Director of Summer Courses in Botany; Mr. Amon B. Plowman, Mr. J. R. Johnston.

COURSES: I. *Introductory Course: The Structure, Physiology, and Ecology of Flowering Plants.* "Several lectures will be offered, dealing with methods in the teaching of botany in high schools." Dr. Leavitt, Mr. Johnston. II. *Morphology, Histology, and Ecology of Flowering Plants.* Mr. Plowman.

THE UNIVERSITY OF MISSOURI. June 10 to August 10.

STAFF: Mr. H. S. Reed.

COURSES: s1. *General Botany.* 8b. *Histology and Cytology.*

NEW YORK UNIVERSITY. July 6 to August 16.

STAFF: Dr. C. Stuart Gager, New York State Normal Collgee, Albany, N. Y.

COURSES: 1. *Physiology.* 2. *Ecology.* 3. *Morphology.* 4. *Aims and Methods* (for teachers). *Special Lectures* at the New York Botanical Garden by members of the Staff.

UNIVERSITY OF WISCONSIN. June 26 to August 4.

STAFF: Professor R. A. Harper, Dr. R. H. Denniston, and Assistant.

COURSES: 1. *General Botany,* Professor Harper, Dr. Denniston. 2. *Algae,* Professor Harper and Assistant. 3. *Fungi,* Professor Harper and Assistant. 4. *Mosses and Ferns,* Professor Harper. 5. *Vegetable Histology,* Dr. Denniston. 6. *Native Trees and Shrubs,* Dr. Denniston. 7. *Physiology of the Cell,* Professor Harper and Dr. Denniston. 8. *Special Physiology of the Flowering Plants,* Professor Harper.

WOODS HOLL. MARINE BIOLOGICAL LABORATORY. June 1 to October 1.

STAFF: Dr. Bradley Moore Davis, Assistant Professor of Botany, University of Chicago. Dr. George T. Moore, Physiologist and Algologist, U. S. Dept. of Agriculture. James J. Wolfe, Adjunct Professor of Biology, Trinity College, Durham, N. C. Dr. Robert Bradford Wylie, Professor of Biology, Morningside College, Sioux City, Iowa. Lillian J. MacRae and Alice E. Dacy, Collectors in Botany.

COURSES: *Investigation:* A. Under Supervision—Morphology, Physiology, Plant Physiography. B. Without Supervision—Information by writing to Professor Bradley M. Davis, University of Chicago.

Botanical Instruction (June 28 to August 9). *Thallophytes,* Dr. Davis or Moore, Wolfe, and Wylie. *Cell Studies,* Dr. Davis and Assistant. *Plant Physiology,* Dr. Moore and Assistant. *Botanical Lectures and Seminars,* by investigators, guests, and members of the staff.

OHIO STATE UNIVERSITY. Cedar Point Lake Laboratory.

STAFF: Professor O. E. Jennings.

COURSES: *General Botany, Ecology, Special Work.*

Volume 8 **Number 6**

The Plant World

A Magazine of Popular Botany

JUNE, 1905

A BOTANIST'S TRIP TO JAVA.

BY FRANCIS RAMALEY,

Professor in the University of Colorado.

Any intelligent traveler should enjoy a trip to Java, but for a botanist there are many features of special interest. No region of the world has a more luxuriant tropical flora and nowhere else is there found such a garden as that maintained by the Dutch government at Buitenzorg.

Java is a long way from the United States, but it does not seem so far from home as in the old days before the American occupation of the Philippines. One may go to Java by way of Europe or by way of Japan. The time is about the same either way. Going west from San Francisco Japan is reached in eighteen days and Hong Kong in ten days more. From there it takes six days to Singapore at the end of the Malay Peninsula. Then a short two-day voyage brings the traveler to Tanjong Priok, the port at which most visitors arrive on the island.

To one with little knowledge of the tropics, Java presents a series of unknown beauties.

> "Each morn unfolds some fresh surprise."

The small coral islands, fringed with waving palm trees, make a pleasing introduction to the tropical luxuriance which crowds in upon us on every side.

I found the custom-house officials at Tanjong Priok by no means exacting. In fact they passed everything without so much as a look. When I explained that I had no firearms or liquors but a great many kodak films, they looked wise and smiled, though they probably did not understand. Most of the Dutchmen in Java are said to "understand English," but the exact amount is not stated.

While one would gladly spend some time along the coast, studying the mangrove vegetation, or put in a few days at Batavia, the capital of the Dutch East Indies, it is best to go at once to Buitenzorg. For in Buitenzorg are assembled all the plants to be found anywhere in the Java lowlands.

There is, however, one preliminary which must not be forgotten. The visitor first goes to the police in Batavia and gets a "permit to live" in the island. Without this permit he is subject to a fine for each day of continued existence.

Buitenzorg is reached in an hour from Batavia. The train passes, now through dense jungle, now between vivid green rice fields, and again through plantations of tea and coffee and cocoa. How different is all this from the agricultural districts of our own land! I was much interested in a kind of tree that is planted for shade in the tea fields. Later I learned that it is the "silk cotton tree," *Eriodendron anfractuosum;* it is quite generally planted throughout the tropics. With its awkward, horizontal branches it forms a striking feature of the landscape.

Here and there, along the way to Buitenzorg, one sees the cheap huts of the natives, each with its grove of cocoanut palms and its banana patch; even from what appears impenetrable jungle these gaily dressed people peer out shyly at the passing train. The railway seems a very cosmopolitan institution. The conductors are Dutchmen, the engineer and other trainmen natives, the ticket sellers are invariably Chinamen. But the train goes quickly enough, and Buitenzorg is reached all too soon, long before one sees enough of the passing landscape.

There is a good hotel in Buitenzorg near the entrance to the Botanical garden. The hotel grounds are planted with ornamental shrubs and trees. At the time of my first visit the large *Terminalia* trees were losing their leaves. These, as they ripened off, showed the bright tints that we, in temperate regions, call "autumnal colors." Some of the tourists whom I met asked if these trees were diseased that they should thus lose their leaves. They were much surprised to learn that many tropical trees behave in this way, being truly deciduous. It is to be noted, however, that the deciduous trees of the tropics do not all drop their leaves at the same season of the year. Still all of the trees of a given deciduous species become bare at about the same time year after year. Deciduous trees are more common in countries where there is a distinct dry season. In Buitenzorg and throughout western Java the "dry season" is dry only in name, for even during that period there is considerable precipitation. The total rain-fall for the year is about five meters (191.8 inches).

The garden at Buitenzorg is likely to be somewhat disappointing at first sight. It is not arranged as a "show" place. English people, especially, remark at once the absence of the wide lawns which they love so well. Everyone is surprised that there are not more showy orchids and beds of flowering herbs. But the beauty of a tropical garden is of a different type from that of one of our city parks. People quickly learn to prefer the less formal garden of the tropics. In Buitenzorg one need not feel a lack of orchids and showy flowers. There are orchids a-plenty but they are no handsomer than the ones we may see any time in our own greenhouses. But besides these conspicuous orchids with which we are familiar, there are hundreds, nay thousands, of species with smaller or less brilliant flowers. These are quite as interesting for their floral mechanism as are their more brilliant relatives. The botanist can enjoy reading accounts of orchid flowers when he has so many species for examination.

It is, perhaps, needless to state that the greater part of the botanical garden is planted with trees and shrubs, and that only a few herbs are represented. The plants of the tropics are mostly large and the herbaceous vegetation of comparatively little consequence. There are some plants growing in beds in Buitenzorg which we know well in hothouses, such as species of *Salvia* and *Lantana* and *Hibiscus*. A handsome plant of the caper family is *Gynandropsis speciosa*. This looks like our own "bee plant" of the western states (*Cleome serrulata*), but much improved in size of flower. Species of *Stachytarpheta, Musaenda,* and *Eupatorium* look familiar enough. They are all fairly common along roadsides in Java. The first resembles closely our wild verbenas of the western United States and the *Musaenda* would be taken for a *Lantana.* It was a pleasure to see in the herbaceous garden a sun-flower plant in full bloom but it looked a little the worse for the damp weather. Certainly it was not as much at home as it would be on a Kansas prairie.

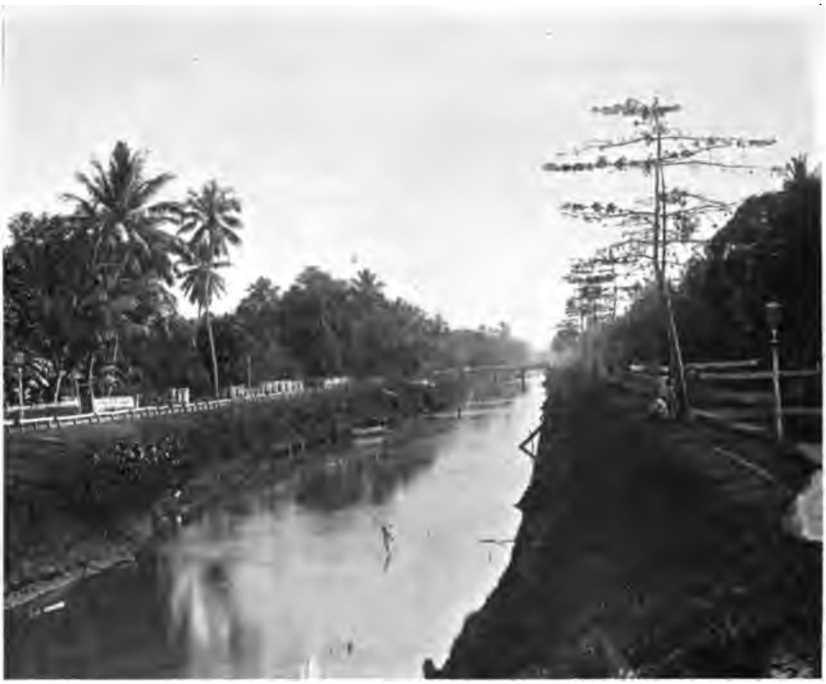

FIG. 31. Date-palms at the left, *Terminalia* at the right.

It is among the trees and lianas, however, that we see the typical parts of the Buitenzorg garden. Those of us who know, perhaps, fifty trees and half a dozen climbers think we have a good idea of our own forests but a knowledge of only such a few plants would not even be a beginning in Java. The botanist needs only a short stroll along some of the well graveled paths at Buitenzorg to become truly humble. The scientific names of the trees are all new to him. Now and then, if lucky, he sees a plant name which he has read in some book but with most of the names he is entirely unacquainted. The names of families even are not familiar; or if he knows them it is in connection with some herbaceous plant of his northern home.

There are tall trees belonging to the Aster family, the Spurge family and the Nightshade family. While ornamental herbs are few, trees and shrubs with handsome flowers continually attract attention. One large tree, *Spathodea campanulata,* is very conspicuous for its red, bell-shaped flowers. It is a native of Africa but now quite generally planted throughout the tropics. *Amherstia nobilis,* from British India, is another tree with handsome red flowers. We; who have in our cold, forbidding country, few trees with conspicuous flowers, can scarcely imagine the beauty of a forest scene in which the somber green of the foliage is ever and anon lighted up with masses of flaming red or soft shades of pink and lilac.

The various edible fruits which are seen growing in the garden may be eaten at the hotel. At the time of my visit (February to April) these were very numerous. Probably the favorite fruit is the mangosteen, *Garcinia mangostana.* This is about the size of a very small orange, but it has a hard, woody, outer rind, dark reddish brown in color. The servants cut the rind around the equator of the fruit before bringing it to the table. When opened up the pinkish interior, in sections like an orange, is all ready to be eaten. I find it quite impossible to describe the taste of the mangosteen. There is a gelatinous quality and a certain sweetness, but above all a most pleasing flavor which is absolutely unique. Other fruits there are, such as the duku and the rambutan, which are quite as beautiful to look upon and which have a mucilaginous sweetness, but they lack that essential flavor which kind nature has given us only in the mangosteen.

A very different kind of fruit from these is the durian. Some men there are who eat this fruit and claim that it is good to eat, but I, for one, could not enjoy anything with such a rare combination of vile odors. First one thinks of rotten eggs, then of sewer gas and garlic and finally he gives up any attempt at a classification of the different smells. The fruit is the size of a small watermelon with dark green, warty rind. Inside it is pale yellowish and of a dough-like consistency. The doughiness causes a peculiar feel in the mouth when eaten and is rather pleasing when taken in connection with the nutty flavor and sweet taste. A young Dutchman with whom I became acquainted had his servant, or " boy," bring a collection of different fruits to the hotel. Among these was a durian. This was placed upon a table on the porch and there cut open. I was taking my regular afternoon nap at the time but the smell of the durian wakened me and I got up at once to see what was the matter. Fortunately my friend did not feel slighted because I did not like the durian. He really had it brought as a joke. There were about twelve other fruits which I tasted, some inoffensive, some rather good. Most of these have no English names and are never seen in our markets. The oranges in Java are poor, but pineapples and bananas are excellent. Such fruits as grapes, peaches and pears are not successfully grown, but strawberries are said to do well in the highlands.

Probably the sections of the garden which strike the casual visitor most forcibly are those devoted to the palms and to the Pandanaceae. The former are certainly among the most graceful and beautiful of living things, while the latter are among the queerest and strangest. The royal palm of Cuba, *Oreodoxa regia,* is seen to good advantage in the garden. After getting acquainted with it there I often noticed it planted about the city. There are hundreds of other palms, some shrubby, as *Nipa fruticans,* others of enormous size. Some, such as the species of *Phoenix,* have dense symmetrical crowns, others are tall and slender. Contrasting with these graceful forms are the pandans —wierd looking trees with prop roots sticking out on all sides. The large dry fruit looks something like pine cones. These, with the spiral arrangement of the clustered leaves, have caused the plants to be called " screw pines."

The botanist who goes to Buitenzorg is sure to look for and study the plants of economic value—and there are hundreds of these. Most of them are in the agricultural garden, about three miles from the city. There are groves of mahogany and ebony and all sorts of spices and medicinal plants. This division of the garden is well liked by globe trotters and business men because they have at least heard of some of the things which are to be seen there. The botanist enjoys all this and he likes the main garden too for its beauty as well as its scientific value. While the tourist glances around the botanist actively looks at things. He enjoys the luxuriance and wealth of beauty, but he sees more than this. The rare plants or those of historic interest

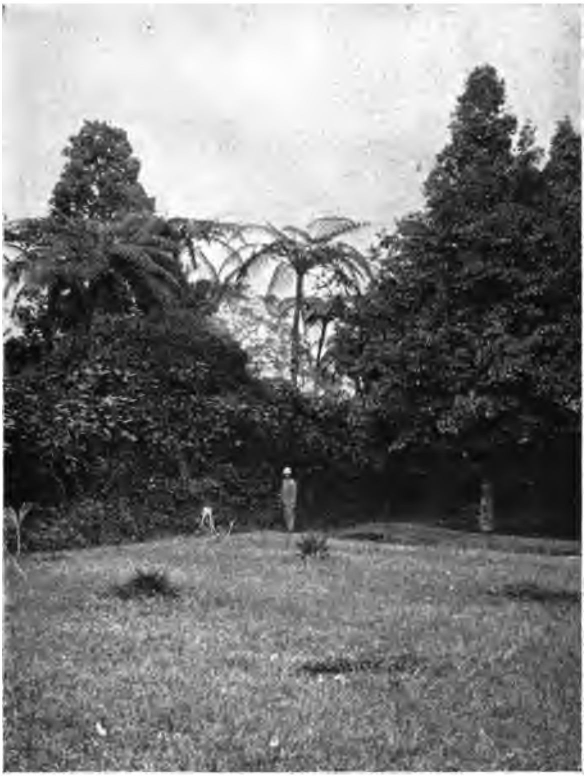

FIG. 32. Tree-ferns in the Botanical Garden at Buitenzorg.

mean much to him. I, for one, felt something akin to awe as I stood among the cycads and thought of those ancient days which these scattered remnants of a noble race recalled. And then the tree-ferns too—they brought up pictures of geologic ages long gone by. To see with one's own eyes living specimens of *Gnetum* and *Ephedra* and *Psilotum* is a great joy to the student of plant phylogeny. But these are only a few of the many things to be seen at Buitenzorg.

A visit to some of the nearby plantations is easily made. At these can be seen chocolate and coffee and tea grown on an extensive scale. I visited one field where coffee and tea were planted side by side. A German professor who was in the party said he would rather have sugar instead of tea with his coffee. Sugar is, however, more often grown in the lowlands. Buitenzorg, although only eight hundred feet above sea level, is not well adapted for growing sugar or for rubber.

There is some good jungle easily reached from Buitenzorg. Like all jungles of wet tropical countries it is made up of a great many different species. There are no dominant species which give their impress to the landscape. Nearly all the trees have small, entire leaves. The leaf-bearing branches are far above the head but there is considerable undergrowth of *Pandanus* and of the curious creeping and climbing palms of the genus *Calamus*.

To see the jungle in comfort one may go to the mountain garden at Tjibodas, about thirty miles from Buitenzorg. A laboratory with sleeping rooms and kitchen is open to visiting botanists. I spent two weeks there with my native "boy," who acted as cook. Every day I went into the nearby forest where trails have been cut, thus making it easy to get around. My "boy" was not used to this cold, up-country climate but the native care-taker of the laboratory went with me always and helped to find whatever I most wanted. He knew the native names of a great many plants. None of the natives speak English nor any other European language and so I was obliged to talk Malay. But it was easy to learn enough to make myself under-

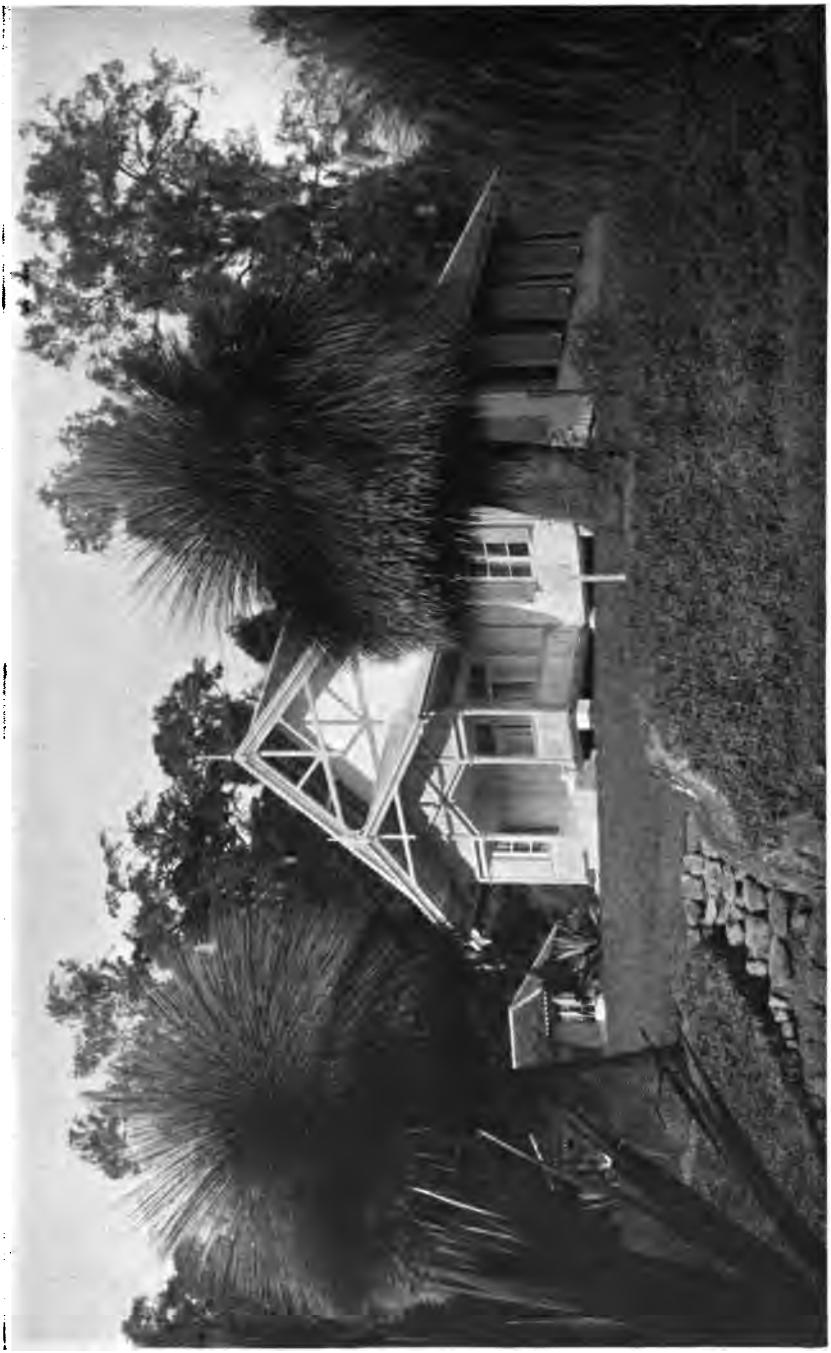

FIG. 33. Laboratory in the mountain garden at Tjibodas. Grass-trees on either side.

stood. During my entire stay in Java I always carried a Malay hand-book with me.

Tjibodas is at an altitude of about 5,000 feet, so the weather is cool and comfortable. While I was there the temperature ranged from 60° Fahrenheit on the coolest night to about 75° on the warmest day. The relative humidity was 100 through the night and seldom went below 90 even on sunny mornings. It rained every day. Species of *Phoenix* do fairly well under these conditions but most of the palms in the garden have a sorry look. Aside from the native jungle plants the trees which thrive best are the conifers, especially the *Araucarias*. There are also good looking *Eucalyptus* trees and the curious "grass tree" from Australia. I noticed one sorry specimen of our tulip tree (*Liriodendron tulipifera*) much the worse for its wet environment. The trees in the jungle, however, grow immensely tall, especially the rasamala, a species of *Liquidamber*. It is difficult to see anything of the trees except the trunks because the branches are all so far overhead.

From Tjibodas one may ascend the Gedeh and the Pangerango. These peaks are the highest in Java and reach an altitude of 10,000 feet. I went up with a native guide and we had some coolies to carry blankets and food. We reached the shoulder which connects the two peaks about noon. It was cold. There had been a drizzling rain all morning. We stopped in a small tumbled down hut which had a very leaky thatched roof and only a dirt floor. The coolies made a fire which filled the hut with smoke but they didn't mind it. They could now get warm, and they needed to, because, like all Javanese, they wore only blouse and short trousers of cotton with no shoes or stockings.

I went with the guide up the Gedeh through the rain. The trees grew smaller and more gnarled the further up we went. At Tjibodas the general level of the forest top had been perhaps a hundred feet from the ground with some trees standing far above this height. But here, on the mountain, the trees were scarcely thirty feet. In the lower part of the climb we found some of the curious parasitic *Balanophoras* familiar to all who have read Kerner "Natural History of Plants." All the trees were densely festooned with moss. Nearer the top the mosses were largely replaced with lichens, *Usnea* and *Cladonia*. There were various heaths, one a fine *Rhododendron*. I noticed a shrubby *Gnaphalium* with the usual xerophytic appearance of the members of that genus. The lower part of the plant was black. This blackening was especially pronounced in specimens growing on lava beds of an old crater. We went down into this old crater and saw the few plants which constitute its flora. There was the *Gnaphalium*, a tall *Polygonum*, a *Carex*, a small fern and three heaths besides some much gnarled trees of the papilionaceous genus *Albizzia*.

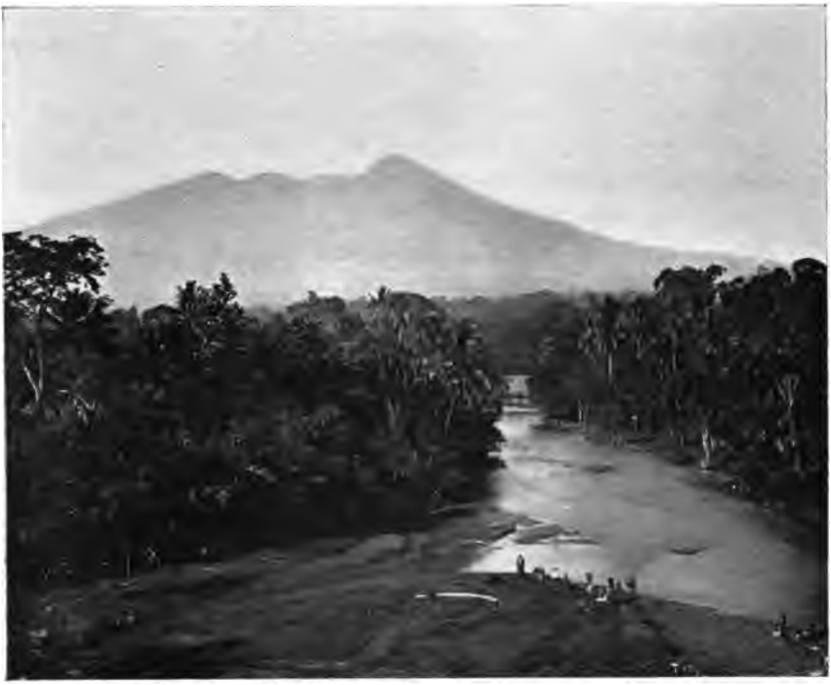

FIG. 34. View from rear of Hotel Bellevue, Buitenzorg, Java.

We went across the old crater on the partly disintegrated lava and climbed to the margin of the new crater. Here we looked down to a lake of boiling mud with jets of steam shooting out everywhere. In many places there were yellow streaks of sulphur and the odor of hydrogen sulphide was very apparent. The sides of this active crater had no vegetation at all.

On the following day, after an attempt to sleep in the cold and smoky hut with everything dripping with water, we climbed the Pangerango. Here the sun came out bright and fresh. I found specimens of a shrubby *Hypericum* and the tall and handsome *Primula imperialis.* The latter is restricted in range to this one mountain. From the top of the mountain there was a beautiful view of the lowlands with rice fields, palm groves and coffee plantations. Just beneath us was a vast stretch of virgin forest. Far away at the left were the still waters of the Java sea and at the right the hazy outlines of distant mountains.

A week later I took the steamer for Singapore and as our good ship bore away northward I looked back with pleasure upon this far-away mountain and recalled again the wonders and beauties of Java—the garden island of the Asiatic tropics.

CACTUS AS A FORAGE PLANT.

By W. J. Spillman,

U. S. Department of Agriculture.

Any one who has traveled in the southwest has noticed the great abundance of prickly pear and other cacti growing even in desert regions. Recent investigations indicate that these plants have in them economic possibilities of no small importance. They are greatly relished by all kinds of stock, particularly by cattle and sheep; they grow in the most unpromising situations; and, most important of all, they retain their succulence and food value for many years, being ready for use whenever needed. For more than half a century the Mexican freighters of southwestern Texas have fed their oxen on cactus, frequently giving no other food. The method employed for getting rid of the spines which cover the plant has usually been to hold the stem over a flame till the spines are burned off. When thus treated the plants are readily eaten, and may form the major part of the ration, though it has been found decidedly advantageous to feed a small quantity of concentrated material, such as cotton seed meal, in addition.

About twenty years ago it was discovered that by macerating prickly pear in a "pear cutter," an implement similar to the ordinary fodder cutter, the spines were rendered innocuous, partly from abrasion and partly from the softening effect of the juices of the plant. Since that time prickly pear has been fed extensively by stockmen in southwestern Texas, particularly in years of slight rainfall, when the grasses on the ranges failed. One of the leading stockmen of that section estimates that the possibility of using prickly pear for stock feed increases the amount of stock that may be safely kept on the ranges by 100 per cent. In ordinary years no pear is fed, but reliance on it in dry years enables the ranchman to keep his ranges stocked to the limit in good years. The great value of prickly pear lies in the fact that in years of famine the herds are not wiped out by starvation as they were before the stockmen learned to use these plants.

In the vicinity of San Antonia dairymen very generally use prickly pear in feeding their cows, and many of them have come to regard it as a valuable asset.

Another interesting method of preparing the cacti for feeding is to scorch the spines off by means of a "pear burner," a modification of the ordinary plumber's torch. The plants are treated *in situ* by this method and left for the stock to eat at their leisure. Two forms of these burners are in general use in the region south of San Antonio, as are also two forms of the pear cutter mentioned previously. It is quite amusing to see a herd of cattle run eagerly to the point where they hear a burner begin to blow, or where they see smoke arising from a brush fire, which they always do after they have learned the significance of the operation.

Whether this class of plants will become of sufficient importance to justify their artificial propagation and the protection of the better spineless forms by rabbit proof fences, remains to be seen. It seems probable that such will be the case in some localities. In one instance the amount of feed secured per acre from a pear thicket was sufficient to furnish all the roughage for ten head of cattle for six months. If a harvest of this character could be secured once every five years, this would be the equivalent of the coarse feed for one head per acre the year round. There are few acres of farm land in any section that yield more than this. The office of Grass and Forage Plant Investigation in this department are now conducting extensive investigations on methods of propagation, yield, food value, and methods of feeding cacti. Bureau of Plant Industry bulletin No. 74, just issued, gives the results of preliminary investigations conducted last season.

THE SPRING FLOWER SHOW AT THE ORCHARD STREET SCHOOL.

Several times a year the hearts of the children living in flowerless sections of the city of New York are made glad. On May 16th, 17th and 18th the pupils of school No. 42, at the intersection of Hester, Orchard and Ludlow Streets, presided over by Miss Harriet Field, failed to recognize their playground, it having been transformed into a veritable fairyland by the tireless energy and love of Mrs. J. Northrup and her able assistants, Mrs. Ricketts, Miss Field, Miss Cohen and Miss Strassburger. In this congested foreign quarter flowers are very rare and few of the children have been to the parks; or even ridden in a street car. The teachers have attempted to take some of them to green fields, but car sickness has proved too great a bar. So the mountain has had to came to Mahomet. Blooming branches of apple and dogwood trees and the snowy bells of the snow-drop tree (*Halesia*) covered and beautified the pillars in the playground. There were also branches of flowering box, Judas tree, spice bush, hickory, hazel, chestnut, white and red oak, elm, horse chestnut,Norway and sycamore maple, the beautiful copper beech, birch, staghorn sumach with last year's fruit, the plum-leaved and other viburnums. Thorn, bladder nut, pink-flowered dogwood, Southern magnolia, honeysuckle, Japanese quince, bayberry, blue, black and raspberry, gooseberry and wild grape.

Among the conifers were larch, cedars, pine, spruce and hemlock. The ' swamp table ' had various equisetums, grasses and sedges, marsh marigolds and butter cups, morels and ribbon grass, and a group of pitcher plants, which must have been fascinating, for all the flowers soon disappeared. Here, too, was a twig with cocoon and the escaped Prometheus moth, several turtles and a tent caterpillar in a glass house. On the same table, their beauty enhanced by the varied swamp greens, were *Orchis spectabilis, Cypripedium acaule,* the pale lavender cancer-root, and the exquisite fringed polygala, well named " gay wings," for they seem always poised, bird-like, ready for flight. Other wild flowers consisted of *Trillium grandiflorum,* pure white and rose pink, others duller according to their age; the deep red trillium and the painted one. Dutchman's breeches, squirrel corn and Dutchman's pipe would have given comfort to any visitor of that nationality. The pipe was unanimously voted perfect. Beautiful were the white blooms of May apple between their umbrella-like leaves, and the Indian paint brush lent a bit of vivid color, as did in a lesser measure the golden club. Buttercups, sassafras, dwarf ginseng, *Phlox sublata* and the rock pink, geum, bluets, columbine, saxifrage, fawn lily, wild geranium, ground ivy, celandine poppy, catnip, violets (many purple varieties, *V. rostrata* being very plentiful, *V. blanda, rotundifolia, canadensis* and *pubescens*), baneberry, azalea, in fact all of our wild flowers were well represented if I except spring beauty. Evidently everyone thought there would be a surplus, with the result that there were only two or three sprays. Ferns of many kinds were there, including the *Osmundas,* maidenhair, aspleniums, *Onoclea sensibilis* and several others.

The collection of cultivated flowers consisted of sprays of bridal wreath, which one boy called pop corn bush, a few sprays of the fragrant daphne, geraniums, narcissi, rhododendrons, the flaming hardy azaleas, abutilon, immense paeonies, a white lilac which bore triple flowers, forget-me-nots with double flowers, very large English daisies, single and double kerrias, pansies of all shades, roses, purple and white flag, lillies, weigelia, laburnum, wall flowers, stocks, very small tulips, dark rose color, the flower about two inches in length; also very large, showy ones, and the picotee tulip, snap-dragon, which had to prove that its title was good; and the English cowslip, called by the Germans key-flower or schüsselblume. This name has heretofore puzzled me, as there is no resemblance to a key, but it has occurred to me that in Germany it is regarded as the key to the spring or to nature's flower opening.

PAULINE KAUFMAN.

THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA. ANNOUNCEMENT.

THE OLIVIA E. AND CAROLINE PHELPS STOKES FUND FOR THE PROTECTION OF NATIVE PLANTS.

Under a resolution of the Scientific Directors of the New York Botanical Garden, adopted in January, 1902, authority was given for the use of the income of the Stokes Fund for the payment of prizes for essays upon the preservation of wild plants, including shrubs, herbs and trees, and for the publication and distribution of such essays. These are to be first printed in the *Journal* of the Garden, from which they are also to be issued as separates and distributed to all interested. The republication of these essays in other journals, magazines and newspapers is invited.

The following prizes are offered for this year, payable December 15th:

1. A prize of $25 for the best essay on local needs in the vicinity of New York City, not to exceed one thousand words.
2. A prize of $15 for the best essay indicating local needs in the parks of New York, not to exceed one thousand words.
3. A prize of $10 for the best essay, not to exceed five hundred words, indicating needs of any locality.*

Essays may be submitted not later than November 1, 1905, to the Director-in-Chief of the New York Botanical Garden.

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* The following essays, reprinted by permission of the Seal Harbor Improvement Society, will serve as an excellent model.

A PLEA FOR THE WILD FLOWERS.

It is to the interest of everyone that beautiful and characteristic plants be guarded from extermination. It is believed that every one will be ready to aid in this work if once he or she fully realizes the danger with which these plants are now threatened.

It is not our wish to discourage unnecessarily the gathering of wild flowers and ferns for decorative purposes. We ask only that they be picked with care and discrimination. Such a flower, for example, as the blue-bell should always be cut with the scissors or a knife, rather than picked, to prevent its being uprooted; and, even when cut, care should be taken to gather it only where it grows most abundantly, that no picturesque tuft be so completely done away with as to set no seeds for another year. Where there is an especially fine plant or colony, or where there is a single plant or a small colony, why not leave at least half the flowers for seed, in the one case giving nature a chance to perpetuate and develop the best, and in the other helping nature to extend her work of beautifying our surroundings?

The pink lady's-slipper, or moccasin-flower, the purple fringed orchid, the calopogon, pogonia, and indeed all the orchids, should be cut (not picked) fairly high up the stem, leaving, whenever possible, the lower leaves intact.

If these flowers are not to be exterminated, they should not be gathered at all unless found growing very abundantly, and then only in moderation. Such fragile blossoms are more effective if not heavily massed, but arranged in a few sprays by themselves.

From the purchase of the rarer flowers, especially of the purple fringed orchid, sabbatia, fringed gentians, or mayflower, we urge every one to abstain. Children sometimes offer them for sale, innocently enough, but those who buy, and so induce the gathering and selling, are the most dangerous enemies of all rare salable flowers.

The bunch-berry is another plant which is less abundant now than it was a few years ago, owing, we fear, to careless uprooting, and stands in need of protection.

Ferns, also, should be picked with care, and not too freely, unless in spots where they are unusually abundant. The same caution should be used against breaking branches from shrubs and trees in so rude a fashion as not only to cause a temporary disfigurement, but perhaps a permanent injury. The hobble-bush, whose effective leaves and brilliant berries decorate gaily the woods of late summer, is frequently a victim to careless picking.

The flowers growing in the immediate neighborhood of the roadside are a joy to the many. Is it too much to ask that these be left to delight the eyes of the passer-by, and that the flowers desired for decorative purposes be sought a few feet from the highway or even from the trail? These roadside plants are constantly enjoyed by those who by reason of age or some infirmity could otherwise never see them. Were this once realized, few would hesitate to take the trouble entailed by half a dozen extra steps.

Many of the most effective flowers may be gathered, away from the wayside, without fear of doing any permanent injury. Daisies, buttercups, clover, wild roses, meadow-sweet, steeple-bush, asters, goldenrod, and other vigorous and abundantly growing plants will yield ample material for decoration, and may be gathered almost with impunity.

To sum up we urge:—

1. Moderation. (Not gathering too many flowers of the same kind in one locality.)
2. Care. (The use of scissors or knife.)
3. Judgment. (Guarding the roadside and conspicuous locations.)
4. Occasional total abstinence. (In case of especially rare flowers.)

THE TEACHERS DEPARTMENT.

EDITED BY DR. C. STUART GAGER.

THE ANTI-FERMENT REACTION IN TROPISTIC MOVEMENTS OF PLANTS.—Under the above caption Czapek (*Ann. Bot.*, 19, 75, 1905) describes his recent experiments which will be of considerable interest to all teachers. In brief the experiments show that the geotropic stimulus causes a retardation in the metabolism of the plant.

As is well known, the only evidence we have that a plant has received a stimulus, as from gravity or light, is by observing some reaction, *e. g.*, curvature of the root or shoot in response to the stimulus. In case the stimulus acts and no movement results two conclusions only have hitherto been possible. Either (1) the stimulus was not received, or (2) the movement, for some cause, could not be executed. In cases where the perception of the stimulus and the responding movement take place in different portions of the plant, as when the root-tip perceives the stimulus of gravity and the curvature takes place in the growing (motor) zone back of the tip, we have hitherto had no means of detecting what goes on in the sensitive zone. The principal explanation offered up to the present time as to the means by which the plant detects the stimulus is the statolith hypothesis of Nemec, which postulates the displacement of starch grains in young cells of the root cap as the mechanism of the plant's perception.

Czapek has already* determined the presence in the root tips of *Vicia Faba major* of one of the inorganic ferments or enzymes known as oxydases, which aid in the oxidation of various substances. He has also demonstrated that these root tips have the power of reducing silver nitrate.

In the present research, when the action of the oxydase was inhibited by chloroform, crystals of tyrosin appeared in the tissues of the root, and the oxydase has been identified as *tyrosinase*. Tyrosinase decomposes tyrosin into ammonia, carbon dioxide and an acid known as ***homogentisinic acid.*** It is this acid that causes the reduction of silver nitrate when the root tips of *Vicia Faba major* are placed in it. This oxydase is further capable of changing homogentisinic acid into a substance that will not reduce silver nitrate. The complete destruction of the tyrosin by the enzyme includes, therefore, the destruction of the homogentisinic acid.

But when roots are placed horizontally there appears, a short time after the stimulus of gravity begins to act, an accumulation of homogentisinic acid. The influence of gravity, therefore, retards the effects of the oxydase.

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* Uber einen Befund an geotropische gereitzen Wurtzeln, Ber. Deutsch. bot. Gesell. **15**: 516. 1897, und Weitre Beiträge zur Kentniss der geotropischen Reizerscheinungen, Jahrbüch. wissenschaftl. Bot. **32**: 207. 1898.

By further experiments it was determined that a special inhibitory substance is formed as a result of the geotropic stimulus. The same phenomenon takes place in all tropistic movements so far investigated. This substance has the properties of an enzyme and "may be characterized as an anti-oxydase, on account of its effect being contrary to that of the oxydase of the root tips. The anti-enzyme produced in geotropically stimulated hypocotyles of *Lupinus* affects the oxidizing enzyme in the *Lupinus* root tip, but not the enzyme of root tips of *Zea Mays* or *Cucurbita.* Furthermore the anti-enzyme produced in phototropic or other tropistic stimulation does not differ at all from the anti-enzyme produced in the same plant by gravity. The anti-enzyme does not exist in unstimulated roots, and after curvature has taken place, following stimulation, there is found no difference in the amount of the homogentisinic acid in the stimulated and unstimulated roots.

It has been demonstrated that the root tips of seedlings rotated horizontally on the klinostat show the presence of the anti-enzyme, indicating that the stimulus has been received. Thus arises a question full of interest for the plant physiologist as to why the root does not bend. This question is as yet unanswered.

Wounds and extremes of light and heat cannot cause the anti-enzyme, but all tropistic stimuli cause it in root tips, cotyledons, stems and other parts. The accumulation of the acid is inhibited by cutting off 1.5 mm. of the root tip and the "anti-ferment reaction" takes place in excised portions of the tip of only 5 mm. in length. Also, in roots of *Lupinus albus,* which do not curve in response to the stimulus of light, the anti-ferment results.

The author does not consider the statolith hypothesis as wholly refuted by his work, though some stimulation effects are present when all the cells containing statolith starch are cut away.

C. S. G.

REVIEWS.

SPECIES AND VARIETIES: THEIR ORIGIN BY MUTATION.*

IV.

New Species of Oenothera.—The experiments with pelories and double flowers demonstrated how varieties originate. How species originate can be learned only by watching the process—by direct observation. Further only the elementary species can be observed to originate, for the systematic species "are only artificial groups of lower unities (and) can never become the subject of successful experimental inquiry." A species must be chosen which is now in a mutating period, and historical evidence leads us to believe that a species in such a condition may be found. After patient observation the evening primrose of Lamarck (*Oenothera Lamarckiana*) was discovered to be in a state of mutation, and plants were transferred to the experimental garden, and seeds sown for the purpose of observation. "Over a dozen new types never previously observed or described" were seen to originate at once—not by slow degrees—from the seeds of this plant. There were 5 groups of these types—1, ordinary varieties, *e. g., laevifolia, brevistylis,* and *nanella;* 2 and 3, progressive elementary species, (2) strong, *e. g., gigas,* (3) weak, *rubrinervis, albida, oblonga;* 4, inconstant forms, *lata, scintillans, elliptica;* 5, forms organically incomplete. The varieties—especially *nanella* and the second and third types—are absolutely constant from seed, showing no tendency to revert to the *Lamarckiana* type. *Lata* bears no pollen. In *scintillans* only a fraction of the seed comes true, the rest are like *Lamarckiana,* and its progeny are largely mutable. *Elliptica* also repeats its type only in a small per cent. of its seed.

Laws of Mutability.—Thus the fact of mutation in plants is established, and as the result of extensive and painstaking pedigree-cultures the following laws of mutability for the evening-primroses are formulated.

1. "New elementary species appear suddenly, without intermediate steps."

2. "New forms spring laterally from the main stem." One species is not slowly converted into another as has sometimes been erroneously held, but new species are derived from antecedent species which may still persist. *Lamarckiana* is in no danger of dying out from the act of mutating. Also the new species originating from an old one are not restricted to one type, but several may spring at once from one parent.

3. "New elementary species attain their full constancy at once." Constancy is not the result of selection.

4. "Some of the new strains are evidently elementary species, while others are to be considered as varieties."

5. "The same new species are produced in a large number of individu-

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* Species and Varieties: Their Origin by Mutation. Hugo de Vries, edited by D. T. MacDougal. Chicago: The Open Court Pub. Co. 1905.

als." No single parent plant of the *Lamarckianas* "proved ever to be wholly destitute of mutability."

6. Mutability and fluctuating variability are entirely distinct phenomena.

7. "Mutation takes place in nearly all directions." There are two possibilities as to how mutation changes may be brought about, and both were propounded by Darwin. "One is the accumulation of the slight deviations of fluctuating variability, the other consists of successive sports or leaps taking place in the same direction."

"The mutations of the evening-primrose comply with the demands made by Darwin as to the form of variability which is to be accepted as the cause of evolution and as the origin of species."

Origin of Wild Species and Varieties.—The origin of new elementary species of *Oenothera* is not an isolated instance, but occurs repeatedly in nature, *e. g.*, in species of heather (*Erica* and *Calluna*), *Brunella, Ononis, Thymus,* bilberries (*Vaccinium*), and campions (*Lychnis*). In considering the problem of how to deal with these cases and what we may learn from them, three points are of first importance. First, to ascertain the constancy of the new type; second, to establish the occurrence or lack of transitional forms; third, to observe a repetition of the origin of the form by experimental pedigree-cultures. The first two points are not difficult to settle. Intermediates are never found. Two suppositions are possible—either they did exist but have perished or else they have never occurred. Since they are never found the supposition most warranted is that they do not occur. The many known cases which show no reversions nor even partial reversions combined with absence of intermediates "makes the hypothesis of a slow and gradual development still more improbable." Mutations have been observed in experimental pedigree-cultures in *Capsella Heegeri* and other plants from time to time and by different writers, *e. g., cruciata* forms of *Oenothera* and of *Epilobium.* Many other instances are recorded. One important point to be noted is the fact that the same novelty has been frequently found two or more times, "and under conditions which make it very improbable that any relation between such occurrences might exist. The same mutation must have taken place more than once from the same main stem." A striking example is the "single-leaved" strawberry which originated independently in Lapland, Versailles, and Holland.

These considerations suggest that mutations are not very rare, and the reason they are not oftener met with is attributed to the fact that they perish in the struggle for existence. "Thousands of mutations may perhaps take place yearly among the plants of our immediate vicinity without any chance of being discovered." More will doubtless now be discovered when observations come to be made in the light of the mutation theory. There is here emphasized the "lack of harmony between common observations and the probable real state of things." "The chances of discovering new mutating species are great enough to justify the utmost efforts to secure them."

Mutations in Horticulture.—The question of mutations in horticulture possess added interest from the fact that Darwin's theory of natural selection was, to a large extent, based upon the experience of breeders. In natural selection we have selection of species within a genus, and selection within the species. So in horticulture there are analogous practices called respectively race-breeding and variety-testing. Careful examination of horticultural facts and practice leads to the conclusion, "that really progressive mutations have hardly been observed in horticulture. Hence the theoretical value of the facts is far less than might have been expected."

Systematic Atavism.—The reversion of a species to the form of some ally from which it is supposed to have descended by the loss of one or more characters is termed *systematic atavism.* A study of systematic atavism shows that the loss of characters is only apparent and that they are present, though latent, even when not outwardly manifest. When in cases of atavism they return to activity, they do so suddenly "and not by a slow and gradual recovery of the former features." The assertion is supported that "the visible elementary characters are essentially an external display of qualities carried by the bearers of heredity, and that these bearers are separate entities, which may be mingled together, but are not fused into a chaotic primitive life substance." Systematic atavism thus emphasizes the importance of the conception of the so-called unit characters. These facts are emphasized by studies of species of *Primula, Androsace, Anthurium, Zea Mays,* tomatoes, and other plants.

"Latency, from this point of view, must be one of the most common things in nature. All organisms are to be considered as internally formed of a host of units, partly active and partly inactive. Extremely minute and almost inconceivably numerous, these units must have their material representatives within the most intimate parts of the cells."

Taxonomic Anomalies.—Characters which are specific in one case often arise as anomalies or as varieties in other instances. They are then termed taxonomic anomalies, *e. g.,* the heaths are considered as one of the lowest gamopetalous plants, but among them Labrador tea (*Ledum*), Indian pipe (*Monotropa*), and wintergreen (*Pyrola*) are polypetalous. "Such cases of atavism make it probable that the coherence of petals has originally arisen by the same method, but by action in the opposite direction. Proof of this conclusion is found in the accidental gamopetals of such polypetalous forms as poppy, *Saponaria, Clematis, Peltaria,* and *Silene.* Taxonomic anomalies are also found in leaves. In all cases, "the idea of a slow evolution on the ground of utility is absolutely excluded. No other explanation remains than that of sudden mutation, and once granted for the abnormal cases, this explanation must obviously likewise be granted for the analogous specific characters.

"Our whole discussion shows that mutations, once observed in definite instances, afford the most probable basis for the explanation of specific characters at large."

When we consider mutation two theories present themselves. Mutation is either a permanent condition of plants or else it occurs periodically. If the former then it has no beginning and is not subject to experimental investigation. If the latter, it had a beginning and this beginning "an external cause," and the phenomenon becomes a fit subject for experimentation. "The amount of mutability and its possible directions may be assumed to adhere to internal causes." The lack of harmony between the demands of the biologists and those of the physicists concerning the duration of life on the earth disappears in the light of the mutation theory. All the facts point to the conception of "mutation periods producing swarms of species from time to time." The intervals between two successive mutation periods may have been centuries or even thousands of years.

The principle of unit-characters and of elementary species leads to the recognition of two kinds of variability, first that due to acquisition of new units or to loss of those already existing, second lesser variations, due to the degree of activity of the units themselves. The latter is fluctuating variability and always takes place about a mean between two extremes.

Again we must distinguish between individual and partial fluctuations. Internal conditions determine averages. Individual fluctuations are due to external causes whose influence begins with the fusion of the sexual cells and may be termed embryonic variability. After germination the external conditions act separately on every part of the young seedling, and partial variability begins. "Individual variability in the vegetable kingdom might be called seed-variation, as opposed to partial or bud-variation." Multiplication of the extremes of fluctuations by seed is always counteracted by individual variability, and thus extremes are best perpetuated asexually, when "improvement" along the desired line may result. This is the origin of nearly all of our largest and more palatable fruits, of the varieties of potato, and improved sugar cane. Varieties propagated vegetatively have the added advantage of being exempt from regression to mediocrity.

Vegetative propagation is restricted to perennial and woody plants. Annuals or biennials must usually be propagated by seed, and races thus improved are notably inconstant. The standard must be kept up by repeated selection, but this very act may result in improving the average and ameliorating the race.

Consideration of the methods of breeders emphasizes the difference between artificial and natural selection. In artificial selection breeding ability (centgener power) is the chief standard for amelioration. Breeders choose seed from the parents having best average yield. But it is not possible to conceive how nature can make use of this principle. In a general way there is an analogy between breeding selection and natural selection, but this analogy "points to the importance of selection between elementary species, and the very subordinate role of intra-specific selection in nature. It strongly supports our view of the origin of species by mutation instead on continuous selection." C. S. G.

Volume 8 Number 7

The Plant World

A Magazine of Popular Botany

JULY, 1905

I.

A BRIEF HISTORY OF ECOLOGICAL WORK IN BOTANY.*

By Howard S. Reed, Ph.D.,

The University of Missouri.

In these days the student of botany hears much of the study of ecology under one name or another. Colleges and universities admit it as a study among other botanical courses; botanical periodicals devote much of their space to descriptions and photographs of the flora of " Brush Creek " and " Driftwood Lake "; and finally the programs of scientific academies are replete with papers upon ecological topics which bear evidence to the present activity in this line of study. It may be, therefore, that some notes on the history of studies along ecological lines may be of interest to the student and teacher.

We have had several excellent summaries of recent progress in ecological studies and some attempts to outline its future, but few have dealt with the work which has stood the test of time. It must not be inferred from this that the subject is without a history or that it is ashamed of its history. But it is reasonable to expect that few retrospective glances would be taken by the students of a subject which has developed so rapidly and in a field where other phases of the work had, in a measure, attained their stature. Some account of past ecological study may perchance be of service as a guide-post, since many seem to be uncertain of the present status of the subject and still more of its future.

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* Contribution No. 5 from the Botanical Laboratory of the University of Missouri. The writer wishes to take this opportunity of expressing his thanks to Dr. William Trelease, director of the Missouri Botanical Garden, for his generous kindness in allowing him the use of valuable library material from that institution.

The writer undertakes to give an historical account, not because he is fitted for the task by knowledge or long acquaintance with the field, but because he, as a student and teacher of ecology wises to trace out the genesis of a subject full of both interest and chaos.

The habits of plants and aspects of vegetation have always been matters of interest and comment by travelers. Undoubtedly our knowledge of the biology of plants would have progressed much faster had they been first studied as living organisms, instead of herbs useful in medicine. For several centuries the chief students of plants were physicians who learned to know them for their medicinal properties. It is extremely interesting, however, to note that the first and perhaps only botanist of antiquity, Theophrastus, records several accurate notes upon the habits and distribution of plants. His description of mangrove swamps and the zonal relation of species are so exact that one has no trouble in making out the character of the societies he had in mind. The nyctitropic movement of leaves is described and termed "sleep movement," and is distinguished from the sensitive movements of Mimosa leaves.

The formation of what we now call *herbaria* dates from the sixteenth century; at that time, however, the word "herbarium" meant a book of dried plants. Previous to that time the authors of books had illustrated their descriptions of plants with drawings or paintings. They were now led to introduce pressed specimens along with the descriptions in order to acquit themselves of the charge of drawing upon the imagination in making their illustration.

During the latter half of the sixteenth century there was a widespread interest in botany in Europe. For the first time in the history of the science, men attempted to record facts as they found them in nature. The figures and descriptions were meant to depict plants as they really were; not embellished with fabulous tales drawn from the imagination. Many of the former descriptions of common plants had been entirely borrowed from the ancient writers and supplemented with superstitious beliefs.

In contrast to the preceding centuries, the peculiar merit of each new publication was held to depend, not on what the writer had borrowed from his predecessors, but on what he had added from his own observation. Hence every one was anxious to introduce into his work as many new or unnoticed plants as possible. The most remarkable thing to us in these descriptions is the striking neglect of flower and fruit. They attempt to depict the form of the plant in words! Special attention was given to the shape of the leaves, the style of the branching, the character of the roots and the size and color of the flowers.

The first men who might be called ecologists were students of plant distribution and, incidentally, of adaptation to the climatic and edaphic conditions of different lands. Later when plants had been named and an attempt at classification been made, students became interested in the life-history of the plant and its physiological response to the factors operating upon it.

These preliminary remarks will serve to introduce us to the work of Andrea Cesalpino, an Italian who was professor at Pisa and later physician to Pope Clement VIII. He died in 1603. If the value of the work of the contemporary German botanists lay in the accumulation of descriptions of plants, the importance of Cesalpino's *De Plantis Libri XVI.* lies in the discussion of the general thory of the subject. He gives in thirty pages a full and connected exposition of the whole of theoretical botany, which, though based on broad and general views, is at the same time rich in ideas expressed in a very concise form. He first seems to have understood the importance of the organs of fructification for classification. He attempts in his blind and often mistaken way, to express some sort of natural relationship between plants, and in so doing laid the foundations upon which Linnaeus built later.

Linnaeus adopted all that the systematists of the seventeenth century had built upon the foundation of Cesalpino's idea, gave it unity and fashioned it into a system without introducing anything essentially new.

That which gave Linnaeus so much importance for his time was the skillful way in which he gathered up and put together all that had been done before him. Linnaeus was born in 1707 at Rashult in Sweden; in 1741 he became professor of botany in Upsala where he died in 1778. We may reckon him as a student of plant distribution, perhaps as a plant geographer, but hardly as an ecologist.

The classification of plants according to the Natural System was carried stilll further by the labors of Bernard de Jussieu and his nephew Antoine. It is the younger Jussieu's great and abiding merit to have first attempted to substitute a real division of the whole vegetable kingdom into larger and gradually subordinate groups for mere enumerations of smaller coordinate groups—an undertaking which Linnaeus had expressly declared to be beyond his powers.

About this time (1793) there appeared what was probably the first work dealing with the adaptations of plants, "*Das entdeckte Geheimniss der Natur im Bau und Befruchtung der Blumen,*" by Christian Konrad Sprengel. The purpose of the book is the explanation of the structure of flowers, their colors and odors. We find in it much of the spirit and method of Darwin but it is often smothered in a teleological atmosphere. Christian Konrad Sprengel was born in 1750 and died in 1816. While employed as pastor of the church at Spandau he became interested in the study of botany. He gradually became more and more interested in botany and correspondingly neglected the duties of his office. It is said that the Sunday sermon was often omitted for this reason. He finally lost his church and went to Berlin where he lived in straightened circumstances, being shunned by men of science on account of his eccentricity. He then supported himself by giving instruction in languages and in botany, using his Sundays for excursions which anyone could join—on payment of two or three groschen. He met with so little encouragement that he never brought out the second part of his famous work; his publisher did not even give him a copy of the first part. Natural disgust with the way in which his work was treated led him to forsake botany and devote himself to the languages.

One by one he takes up and describes the common wild flowers of his country, noting, as he does so, the adaptation they show to their environment and to insects. Setting out with the conception of a "wise author of nature who has not created one hair without a definite purpose," Sprengel's study of apparently insignificant facts brought out a much clearer understanding of the meaning of flowers than had ever been given. He first regarded the modifications of the flower as existing for the sole benefit of insects, but the study of some species of Iris led him to the discovery that many flowers are not fertilized without the aid of insects and finally to the conclusion that "Nature seems to intend that no flower shall be fertilized by its own pollen." One can but regret that Sprengel should have failed to discover the advantages which cross-fertilization brings and to have seen that all the arrangements which favor insects' visits are of value to the plant itself, simply because the visitors effect cross-fertilization.

The opening years of the nineteenth century saw the inception of some phytogeographical work of lasting value. A. von Humboldt had begun his travels and gave vivid accounts of the natural history of unknown regions in such works as his "Essay on the Geography of Plants," published in 1803. In the opening pages of the work cited he recommends the study of plant geography for exemplifying the philosophical side of botany. He states that at that time the science of plant geography scarcely existed, even in name. Humboldt seems to have observed, independently, that plants are grouped into societies or "associations"; and speaks of the differing composition of plant associations in tropical and temperate zones. Later in "Views of Nature" he gives short sketches of the life history of various plants and of the aspects of vegetation in the lands he visited. His work helped furnish the basis for several contemporary treatises on phytogeography.

The foundation of the present science of plant geography as a separate and distinct part of botany seems to have been laid by Schouw in 1823. He was professor in Copenhagen and had been attracted to the study of plant geography by the works of Humboldt. He spent the summer of 1812 among the mountains of Norway and the years 1817–1819 in Italy and Sicily. When he came to write up the data collected on these trips and read the existing works on plant geography, he realized how little had been done toward establishing fundamental laws for the science of plant geography, and himself undertook to formulate the laws and lay down some rudimentary principles for this new science.

We owe to Schouw several of the conceptions and much of the terminology which have become fixed in the literature of plant geography. In addition, he was the first to give definite description of certain societies and to recognize the grouping of plants according to the water-content of the soil. The first part of his book deals with the effect of external factors upon the distribution of plants but like the other plant geographers of the time, he deals principally with temperature. The edaphic factors are fully outlined, but not explicitly treated. The effect of light is very briefly treated: he dismisses it by saying "Without doubt it also serves to nourish the plant."

Among those who laid scientific foundations for important work at the beginning of the nineteenth century, no name is as important as that of Augustin Pyrame De Candolle of Geneva. The amount and compass of his labors as a systematic and descriptive botanist exceed those of any writer before or since his time. In addition to various monographs on morphological and physiological subjects, he set on foot the great *Prodromus Systematis Naturalis,* in which all known plants were to be arranged and described at length, a work in which many other botanists participated, but none to such an extent as De Candolle, who alone completed over a hundred families. His son, Alphonse, took up the work after the father's death in 1841 and completed it through the dicotyledons; the monocotyledons were never worked up.

Alphonse De Candolle inherited the industry and ability of his father and carried out a long series of studies in plant distribution. He published his most important contribution in 1855 under the title "A Systematic Plant Geography." De Candolle, like the other plant geographers of his day, devoted a large part of his work to a treatment of the most evident factor in distribution, viz., temperature. Light and moisture are very briefly treated. His discussion of geographical botany is quite complete and very interesting; treating at some length the distribution of cultivated and native plants, the geographical origin of cultivated plants and the probable origin of existing species.

The year 1859 was made memorable by the appearance of a book whch gave a great stimulus to the study of all biological phenomena, but especially to that of adaptation, Darwin's "Origin of Species." Of all the works which preceded, this one dealt most directly and scientifically with the origin and meaning of adaptation. Following this first great work came further studies on the adaptations of plants—Insectivorous Plants, Climbing Plants, The Power of Movement in Plants, Animals and Plants under Domestication, etc. His books are mainly records of observations on plants as they grew in nature; they are briefly treated here, not because they are unimportant, but because they are so comparatively well known.

The value of Darwin's work lay not only in the wealth of observation and discovery of natural laws, but in the stimulation it gave to further study and experiment. Some who received and believed his theories sought to verify them by further work and observation, others, differing from him, busied themselves with observations and experiments to overthrow his theories.

Among those who oppose Darwin's explanation of variation and the origin of species is Henslow, who stands almost alone in his belief that species have arisen by self-adaptation to the environment.

The methods and spirit of Charles Darwin were not restricted to England, but spread rapidly to other lands. The most fertile soil for the seed he had sown proved to be in Germany and the Scandinavian countries, with fewer though no less important workers in France, Switzerland and Italy.

In Germany we find the work of Anton Kerner von Marilaun, professor in the University of Vienna, beginning in 1863 and continuing down into the recent period of ecological work. His work may be judged by his "Pflanzenleben," published in 1888, which has been translated into English and enlarged by Professor F. W. Oliver. Unfortunately this work which we know as the "Natural History of Plants," is not accurate in all particulars and must be taken *cum grana salis.* We should always regard with suspicion any treatise which never fails to explain glibly any phenomenon of nature which comes up.

(*To be continued.*)

FASCIATION IN FIELD PEAS.*

By Frederick H. Blodgett,

Maryland Agricultural College.

The use of seed or other material of variable character is attended by more or less risk of loss due to impurities and other forms of depreciation more or less beyond the control of the user of the material purchased. When the defect in quality takes the form of "rogues" the loss is evident even to those who would not recognize the source of loss in an excess of weeds or decreased crop as due directly to the unwillingness to pay for good seed. Under conditions unusually favorable to vegetative growth, plants often produce excessive or abnormal parts, or assume freak forms. This happens quite often with the sweet potato, and with other plants at intervals. In 1903 two fields, of a total of fifteen acres or more, were observed in Anne Arundel County, Maryland, devoted to growing peas for canneries, in which the loss due to poor seed was almost total, as there was less than ten per cent. of a crop set, and practically none of this was harvested.

In the truck region of Maryland about Baltimore, it is customary to go over the field of peas several times, taking each time the mature pods only, and finally turning under the vines as green manure. Very little stock is kept by the farmers of the region, hence the vines are not cut and fed as is the case in the western part of the state. Any failure to set a crop of pods therefore becomes a total loss, the more severely felt as there is a large force of pickers on hand by contract at the date of the first expected picking, all of whom must be paid or at least maintained by the trucker.

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*Read at the Philadelphia meeting, American Association for the Advancement of Science, Section G, December 27–28, 1904.

The soil of this region is for the most part of a sandy loam, inclining to excess of sand, and large quantities of city manure, in addition to the turned under legumes and abundant commercial fertilizers, are used by the farmers, resulting in a large amount of available plant food. When a considerable rainfall with warm days, and seeds of unknown quality, are brought together in such a soil, as in 1903, the conditions are so favorable for vegetative development that any weakness on the part of the stock, in respect to setting seed in this case, is almost certain to appear. Seed from reliable sources and of good quality did not develop the tendency to " rogue " as did the poor and lower priced seed.

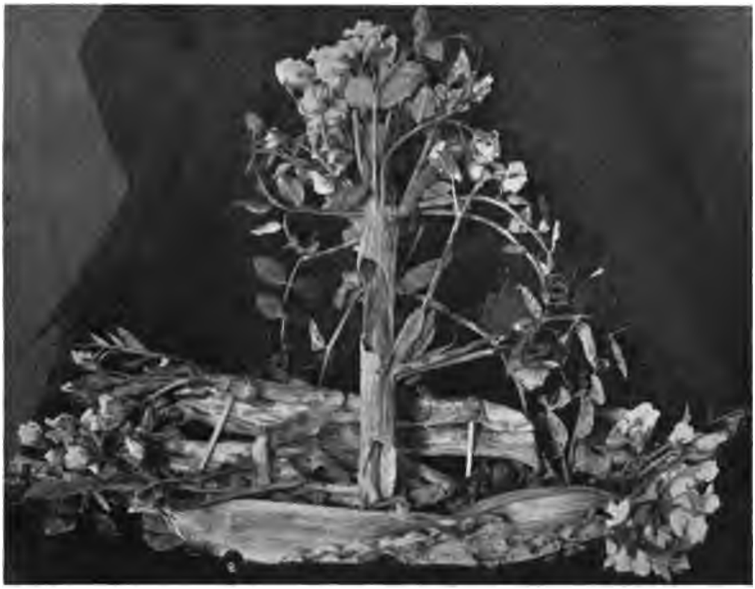

FIG. 35. Stems arranged to show the free inner tube, ½ size.

The truck growers very often purchase their supplies of farm material through the commission men who handle the produce of the farm. The crop of pea seed in 1903 was short and the reliable supplies were secured by the regular dealers, through their contracts with their growers. This left only the unknown seed for the other seed merchants, and in one case at least emphasized the commercial value of a good strain of vigorous plants. When seed is scarce and the prices high it is the more important to buy from reliable seedsmen than when good seed is available to anyone, as they will have supplies of known quality in preference to the occasional or speculative dealer.

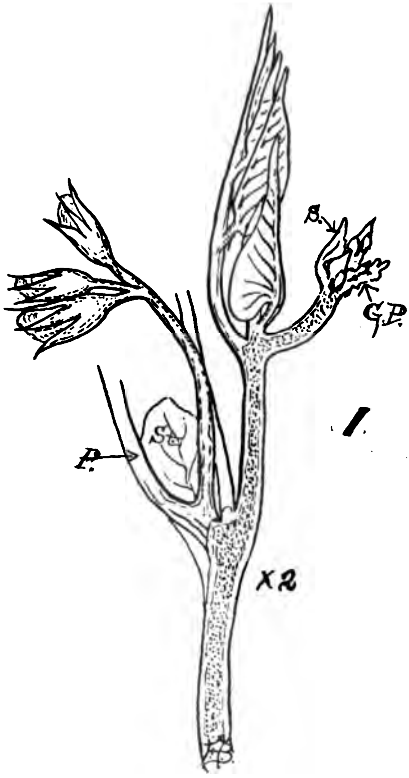

FIG. 36. Longitudinal section of tip and two nodes to show relation of growth units. *S*, stipules; *G. P.*, growing point; *P*, petiole.

The appearance of the affected fields, as first seen, was of extreme uniformity, as if the plants had been cut to a uniform height and had then bloomed. The flowers were confined almost entirely to the region adjacent to the apex of the stem, and were in great abundance, as may be seen from the photographs, of separate stems (Pls. 1–3). In spite of the abundant flowers very few seeds were developed, although the blossoms seemed to be normal in themselves. The few pods that were seen were usually of one seed only, and as the field was plowed before these were ripe none could be obtained for experimental cultivation. Not over ten per cent. of the vines were normal, and no crop was gathered from this small portion.

An examination of the abnormal stems showed an excessive number of flowers at the summit, a hollow and enlarged stem, the actual tip in the form of a ring being hidden under the multitude of buds and leaf elements produced at the edge of the apex of the tube. A few of the stems were split downward for a short distance from the tip and had a tendency to become flattened. These showed the presence of an inner tube, practically free from the outer, and sinuously tapering to a point, which was usually free within the cavity of the stem. Such an internal tube was attached to the inner surface of the outer wall by the most delicate gossamer of cell remnants, and was itself of a delicate texture, the inner surface (of this tube) being smooth and shining, in contrast to the ribbed and dull appearance of the outer wall of the stem. The inner tubes were present in all of the abnormal plants examined, and are shown quite clearly in the illustrations herewith. The upper end of the stem may almost be said to dissolve into buds and rudimentary branches, they so completely hide the tip of the stalk, as can be seen in one of the photographs (Pl. 3). Some of the branches were slightly fasciated also, but were not provided with the inner tube, so far as observed.

The separation of the stem into the inner and outer tubes begins about one cm. from the tip, but does not become complete much short of three cm. from the rim. The disunion of the two portions seems to be caused by the more rapid growth of the outer tubular wall, which elongates more rapidly than the inner tube and consequently tears it from its attachments as soon as the strain exceeds the elastic limit of the thin walled cells uniting the two surfaces. The survival for a time of a few points of attachment between the two parts tends to set up strains in the inner tube, resulting in the puckering and contorting of the more delicate of the two structures. These points of retention are most often found in connection with the origin of a branch, either foliar or floral. In a few cases there were observed leaves or buds arise from the surface of the inner tube. As indicated above the inner tube tapers to a point which is usually free in the tubular cavity, and is about one-third the length of the stem from the tip, indicating something of the relative rate of growth of the two portions, supposing that the tubular structure of the stem began while the plant was still small. This would seem to be indicated by the slenderness of the tip of the inner tube, which was attached to the outer tube by the cellular tissue common to the two parts at that time as the upper ends of the two are now united by their common rim.

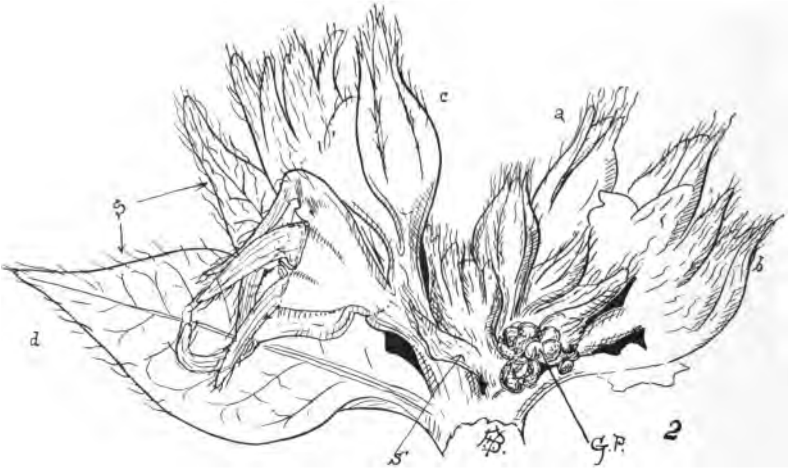

FIG. 37. Apex of Fig. 36, showing the growing point, adjacent buds, etc.

The tip or rim of the stem is formed of a number of growing points, about one mm. apart, and rising about the same amount above the average level of the rim. The intercallary growth of meristem cells between the several growing points results in the tubular stem; this becomes a flat or ribbon stem when any one of the groups of intercallary cells ceases to act. The beginning of the tube form of the stem may have had its origin in the overtopping of the true growing point of the stem by the lateral units or branch rudiments, each of which assumed the functions of the displaced tip, and all were united into a tube through the actively dividing cells at the base of the short stalk or elevation belonging to each separate growing point. This possible origin of the tubular form of stem could only be verified by the rare chance of finding a stem in a sufficiently young state to show the tip still united to the adjacent walls, and the actual growing point still recognizable at the apex of the tapering tube.

This suggested mode of origin is offered as explaining the cases of fasciation here considered better than that suggested by H. S. Conard in the case of sweet potato:* supposing a stimulus to act radially upon the apical meristem. If, as is here assumed, the apical cell becomes overtopped by the outgrowths from the surface of the terminal cone of the shoot, as figured in normal form in Sachs (Physiology, p. 467, 468), no change in direction, from linear to radial, is needed on the part of the disturbing stimulus. On the contrary the only requirement is that the rudiments of the leaf and flower units produced as outgrowths from the meristem shall receive a sufficient stimulation to cause them to exceed the elongation of the true tip. The nascent nature of the cells from which these protuberances arise causes the development of the tissue necessary to unite the several growing points so formed into a tube, which by the death or failure of any group of these connecting cells would form a flat or ribbon fasciation. Under the stimulation each of the shoots or growing points continues to elongate and produces the outgrowths which the tip would have produced and the excessive number of the flowers is thus accounted for. The development of flowers instead of leaves from the multiplied growing points bears some relation probably to the crowding of the young parts upon the rim of the tip. The endeavor to propagate under the given conditions resulting in the floral rather than foliar growth, the flowers so produced being apparently normal, in respect to the several parts, although practically no seed was set at the time when the field was seen, and it was soon after plowed.

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* Publications of the University of Pennsylvania, New Series, No. 6, "Fasciation in Sweet Potato," pp. 205–215, pl. xix.

While the individual growing point functions as the normal tip for the growth unit it bears, these units are not developed upon all sides of the axis except in the rudimentary stage. As soon as they are large enough to be recognized as bud or leaf units, they rotate upon their axes so as to bring their further development upon the outside of the stem; this is shown in the pen drawing (Figs. 2, 3). This is likely to be in response to the light stimulus, and results in the concentration of all the units upon the outer edge of the rim, where they form a fringe-like apex to the stem. This is shown in the stems photographed as Pl. 3, especially the two at the left. In Figs. 2 and 3 the inner side of the rim is toward the lower right hand, with the growing

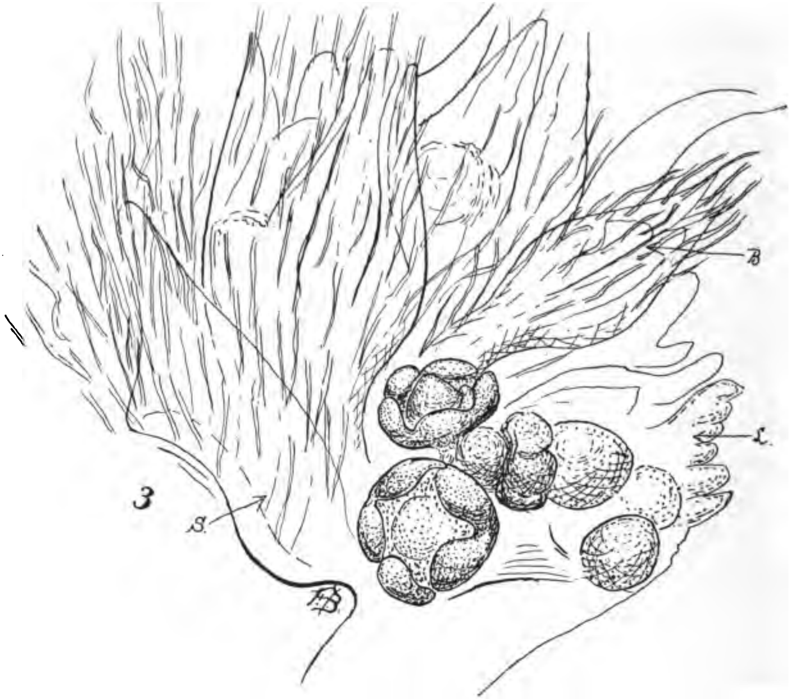

Fig. 38. Part of Fig. 37 enlarged to show character of the rudiments of buds, and the hairy covering of the young parts. *S*, stipules; *B*, buds; *L*, leaf rudiment.

point raised a little (1–1½ mm.) above the edge. A dense clothing of slender hairs obscures the details of the buds until they are separated by the elongation of the internodes. Only a few of these hairs are indicated in the drawings. No hairs were observed on the youngest parts, but were first seen when the sepals are elongating to enclose the flower rudiments, at which stage they terminate in a tuft of the hairs; these become less abundant as the distance from the tip of the sepal or stipule increases.*

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CLEISTOGAMOUS FLOWERS AND THE THEORY OF ADAPTATION.†

Cleistogamous flowers (those in which pollination takes place without the corolla unfolding) have been studied and described by many authors, so that the morphology of many of them is well known; but attempts at explaining them are not so satisfactory. The prevailing theory accounts for them as being an adaptation for securing pollination when insects cannot be relied upon.

Of "adaptation" in general there are two theories:

1. Indirect adaptation, or that resulting from the elimination of useless characters through the operation of "natural selection." That is, there is no direct relation betweeen the adaptive characters and the conditions to which they are adapted.

2. Direct adaptation, or that resulting from the operation of external (or internal) conditions. Of this, various interpretations are possible.

With some botanists this latter theory, that of direct adaptation, involves even a psychological factor. Thus, Naegeli says: "Necessity acts as stimulus" in bringing about adaptive changes. Another declares that plants (or animals) have the power to vary in a useful manner, according to the external conditions.

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* Prepared for the Philadelphia meeting American Association for the Advancement of Science, Section G, December 27–28, 1904.

† K. Goebel, Biol. Centralb. **24**: 673–697, 737–753, 769–787, November, December, 1904.

Some go so far as to ask, For what purpose does a plant produce cleistogamous flowers, implying some kind of consciousness in the plant.

But direct adaptation may be considered as resulting from the action of external forces, without involving in any way psychic factors, nor assuming that of all the possible reactions only useful ones will occur.

To the question whether cleistogamous flowers are merely cases of arrested development or special adaptations of structures for securing self-pollination, various answers have been given. Asa Gray considered them as simply "arrested buds." But there are many "arrested buds" that are not cleistogamous, even in species that do regularly produce cleistogamous flowers. Cleistogamous flowers are characterized by the fact that notwithstanding the arrested development, the pollen-grains and ovules reach maturity and they produce seed. This condition is somewhat analogous to that of dwarfing as a result of insufficient nutrition. In a dwarfed plant flowers and fruit occur earlier than normally, though not, of course, so abundantly.

A further analysis of the characteristics of cleistogamy may be aided by noting Sachs' division of the growing period of a plant into the morphological (in which the rudiments or the primordia of the organs are laid down in their proper numbers and positions, and in which their early growth takes place) and the physiological (in which the organs enlarge to their proper size and attain their functional maturity). In cleistogamous flowers the morphological period is more or less shortened, but the physiological maturity does not seem to be affected, as far as the essential organs are concerned.

Darwin believed that while cleistogamy might in many cases be primarily the result of arrest in the development of the perfect flowers, it was in other plants a special adaptation for self-pollination or for the protection of the pollen.

It remains therefore to be discovered, first, whether there are essential structural differences between chasmogamous and cleistogamous flowers which are not due merely to differences in the degree of development, and second, what the causes of the abortions are. If it is agreed that the cleistogamous flowers are merely undeveloped forms, then there is no need to distinguish between true cleistogamy and "pseudocleistogamy," or that in which the flowers are in all respects like the chasmogamous ones, except for the failure to open. In these the development stops in the last stages before the opening of the corolla, while in the "real" cleistogamous it stops earlier in its course. All intermediate forms have been found, and in the same species (*e. g.,* the touch-me-not) there may often be found all degrees of the chasmogamous, the cleistogamous and the pseudocleistogamous growing on the same plant. The distinction is therefore worthless, thinks Goebel, and it would be more to the point to speak of arrested development and arrested anthesis, or unfolding, of cleistogamous flowers, or of habitual cleistogamy (that which occurs regularly without apparent regard to external conditions), and induced cleistogamy (which may be brought about at various stages in the life of the plant by modifications of the environment). But even such distinctions are not fundamental.

Like Darwin, Goebel divides the appearance of cleistogamy into three cases:

1. Where the cleistogamous flowers precede the chasmogamous.
2. Where the cleistogamous follow the chasmogamous.
3. Where the two forms occur at the same time.

The author then discusses typical species in each group, showing that in certain species the production of cleistogamous flowers occurs regularly according to external conditions, varying principally with reference to seasonal changes in moisture, light and soil- or air-temperature.

He next considers the structural relations in several species, as *Lamium amplexicaule* (dead-nettle), the yellow balsam, *Specularia perfoliata, Oxalis acetosella, Cardamine chenopodifolia* (bitter cress), and several species of *Viola,* to show that the organs of the cleistogamous flowers are reduced structures resulting from an arrest in growth or in development. The rudiments of all the organs found in the chasmogamous flowers of any species are also found in the cleistogamous flowers; but the development of all does not proceed as far in the latter as in the former. Still, in all cases functional pollen-grains and ovules are formed. Whatever differences in structure occur between cleistogamous and chasmogamous flowers of these species are altogether the results of delays in the unfolding of the bud.

There are recorded in botanical literature large numbers of experiments and observations on the influence of nutrition (in the wider sense) upon the size and development of plant organs. Goebel cites many cases bearing especially on the development of the floral organs, to show that arrest of development is in general a function of diminished nutrition. From this he concludes that cleistogamy is always a question of nutrition too insufficient in quantity or too poor in quality to produce perfect flowers. He cites experiments in which plants normally producing cleistogamous flowers either before or after the chasmogamous ones, produced under certain conditions only the one kind, while under certain other conditions only the other. The dependence of cleistogamy upon nutrition may then exist even where it appears with seeming regularity at a certain time in the course of a plant's development, as in *Impatiens* and *Viola*.

The teleological explanation of the origin of cleistogamy is accordingly not tenable. Cleistogamy bears no causal relation either to a lack of pollinating agencies, or to the failure of the chasmogamous flowers to produce seeds. It is rather dependent upon inadequate nutrition, and upon correlation with vegetative organs.

It is important to distinguish between the external conditions which may stimulate changes in the structure of plant organs and the purpose which such reactions may serve. The uses which a structure may serve are not to be confounded with the causes that produce it. Flowers are usually considered less plastic than vegetative organs, that is, as being less influenced in their forms by external conditions,—and in general they are so: but the sizes and number of parts within a flower do depend on the quantity and quality of available nutriment. And the same must be true of cleistogamy, without regard to the advantage or disadvantage this phenomenon may be to the species.

Even such plants as have absolutely no need of them may produce cleistogamous flowers. But among certain plants the ability to produce such flowers has become of great importance because the chasmogamous flowers do not produce seed with regularity.

Finally, the relation in regard to seed-production is the reverse of what it is commonly conceived to be: the cleistogamous flowers do not appear *because* the chasmogamous ones produce no seeds, but the production of seeds by these may be omitted because the plant has cleistogamous flowers. B. C. G.

FASCIATION: ITS MEANING AND ORIGIN.*

"Fasciation" refers to a class of abnormal stems, examples of which are not uncommon and which are easily recognized by the conspicuous banding and enlargement of the axis. At a greater or less distance from the base they become broadened and flattened, showing at the same time characteristic ridges and furrows. The stem splits in the upper and younger part and the two or more segments develop independently, so that although they are not necessarily of the same size, neither one could be recognized as the "main axis." Fasciated stems produce many leaves scattered or crowded so irregularly that there is no sign of the original phyllotactic order. Sometimes the internodes develop unequally, and there results the well-known torsions which most frequently take the form of "shepherd's crooks." The classic example of fasciation is the cockscomb (*Celosia cristata*) where by cultivation this tendency is developed to an exaggerated degree.

The explanation is not a simple one. Since the stem shows normal anatomical conditions and no definite trace of the apparent fusion, there is a class of writers who take an opposing view to that of Worsdell, asserting that the phenomenon is exhibited by one single stem, rather than that it implies the union of several.

Worsdell reviews at length many instances and considers particular cases in detail. In general his discussion is as follows:

There are two tendencies active throughout the production of plant parts. A progressive tendency toward fusion and a retrogressive tendency toward multiplication. The first may be illustrated by the cohesion of the anthers in certain cucurbitaceous forms and by the union of petals in many corollas. The second appears normally in double flowers. It appears teratologically in so-called "twin" flower spikes where on one enlarged pedicel two buds are produced, or where several flowers are crowded together in one plane in a position where there would normally be but a single individual. These instances involve an enlargement of parts due to the union of one or more members. Under this head comes fasciation as defined above.

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* W. C. Worsdell, The New Phytologist, 4: 55. 1905.

Worsdell concludes that of the structures mentioned each represents the final product of two tendencies, one which makes for integrity, and which is the younger, and another which makes for plurality or separation. In its older parts the structure exhibits the tendency to fusion but later in the younger region the tendency to branch. In the development of fasciation there is the same phenomenon as that presented in the staminal group of a flower-like Hypericum, or one of the mallows. The union below and the multiplication above results from the same conflict of forces though the two instances are morphologically so widely separate.

The mechanical cause is probably a disturbance and multiplication of "growth centers." The growth at the apex of a normal shoot is distributed around a central point, the growth center, in such a way that its transverse component is a circle and the circular section of most plant axes is the result. A multiplication of growth centers due to obscure physiological conditions produces distortions. When some centers are weaker than others, the curvatures result. Dichotomy is due to the influence of two equal growth centers and may be called the simplest form of fasciation. An organ tends to revert to its ancestral conditions when its equilibrium is upset, and Worsdell is inclined to think that the banding of a fasciated stem is a reversion to branching in one plane like Lycopods, Ferns and Algae.

Physiologically fasciation is probably a pathological state usually induced by superabundant nutrition. It has long been known that an abundance of manure is necessary to induce the formation of the " combs " in Celosia. A diseased condition may result which produces hypertrophied growth and destroys the balance of the organ.

It must be remembered, however, that the environment is not the only factor, and that the individual idiosyncrasy of the plant must be taken into consideration.

It is interesting to note in this connection that de Vries has carried out and published the results of a series of experiments showing fasciation to be hereditary. A. A. K.

THE TEACHERS DEPARTMENT.

EDITED BY DR. C. STUART GAGER.

THE DAILY PERIODICITY OF CELL-DIVISION AND OF ELONGATION IN THE ROOT OF ALLIUM.*—It is a well known fact that rhythmic variation in the rate of growth in plants is widespread, perhaps universal. This rhythm varies in different plants: each form seems to have its own peculiar rhythm. Thus far there has been little agreement as to the factors involved in the production and maintenance of rhythm. Cell-division as a factor has been almost entirely overlooked.

Very little is known of the actual relations between cell-division and growth. The object of this study was to determine (I.) whether there is a definite daily rhythm in the growth or elongation of a subterranean part growing under much more uniform conditions than the aerial parts; (II.) whether there is a rhythmic daily variation in the rate of cell-division of a growing organ; (III.) if such rhythms exist, to determine whether there is any correlation between the processes of cell-division and elongation.

The daily periodicity of cell-division was studied (I.) under normal conditions; (II.) with regard to the effects of solutions.

The tables constructed as a result of measurements and counts show how remakably similar are the conditions of the root tips examined at the same hour. The similarity is much closer than was to be expected on account of the numerous factors liable to cause individual variations. At 9 and 11 a. m. and 1 p. m. the numbers of dividing cells are almost identical in two separate tips. Some differences occur at 5 and 9 p. m. and 1 a. m. The curves deduced from the tables are remarkably regular, there being two maxima and two minima. Cell-division is most rapid (primary maximum) at 11 p. m. The secondary maximum occurs at 1 p. m. The primary minimum in cell-division occurs at 7 a. m. following the primary maximum. The secondary minimum occurs at 3 p. m. following the secondary maximum.

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* Summary of article by W. E. Kellicott in Bull. T. B. C., Oct., 1904.

Thus there are two regular waves of cell-division during the 24-hour period, a more extensive wave extending from late in the afternoon until early in the morning and occupying therefore practically all of the dark period; its crest appearing shortly after midnight. A less extensive wave occupies the light period of the day, extending from early morning until late in the afternoon. The crest of the wave appears about noon. Both of these waves are remarkably regular. It was found that when the usual rhythm of cell-division is interfered with, the normal rhythm tends to recur when the disturbing factor is removed or overcome.

Roots of *Podophyllum*, studied in precisely the same way, gave similar results. In general the character of the curves for this plant is much like that of the curves for *Allium*, except that there were more extensive minor variations. The maximal and minimal points occurred at approximately similar hours with *Allium*.

The general result of placing roots in solutions, as found by the use of water and glucose and magnesium chloride solutions, is to decrease the rate of cell-division and to delay the normal rhythm.

It is noteworthy that in none of the series could there be seen any direct effect of change of temperature. Nevertheless there can be no doubt that wide variations in temperature would have a marked effect upon the rate of mitosis.

The daily periodicity of elongation was studied by direct observation. Onions were grown in a dark room in pots with a narrow glass slip set in one side. Roots frequently grew almost vertically down along this glass and were observed by candle light with a horizontal microscope. No illumination of the roots was permitted. It was found that there is a rhythm of elongation conditioned solely by internal factors. The primary maximum was found to be about 4 or 5 p. m. and the secondary maximum about 7 a. m. The primary and secondary minima were found to be at 11 p. m. and noon respectively.

The relation between cell-division and elongation is very definite. The rhythms agree in time but always occur in opposite directions, *i. e.,* when elongation is at a maximum, cell-division is at a minimum and *vice versa.* The following composite curve deduced from all the observations made shows this in a graphic manner.

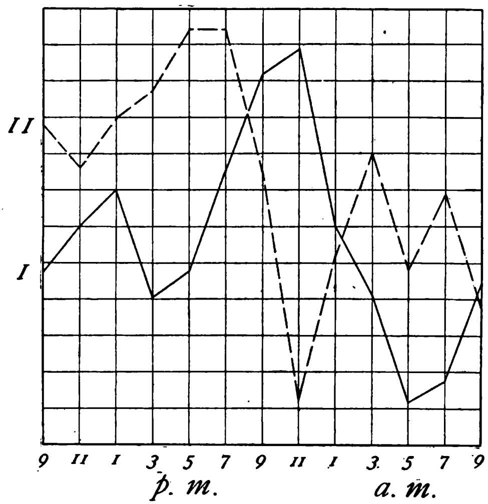

FIG. 39. Composite curves of cell division (I) and elongation (II). (By courtesy of Torrey Botanical Club.)

It would seem that when the cell is dividing and the new cell wall forming, the energy of the cell is diverted from its other growth processes and elongation is arrested.

Rhythmic activity resulting from the uniform action of stimuli is quite universal and it may be that here in the root where external conditions are practically uniform we are dealing with a ryhthm not directly related to its environment, but which results from the activity of the root itself, *i. e.,* it is internal in its origin.

With our present limited information we are hardly justified in making assumptions as to what are the causal relations between cell-division and elongation, both to each other and to the other vital activities of the plant. C. J. M.

THE GREAT ABUNDANCE OF POLLEN.—"You have sometimes noticed in the spring that after a rain the pools of water are surrounded by a ring of yellow powder and you have perhaps thought it was sulphur. It was not sulphur but was composed of millions of pollen grains from flowers. One spring Sunday I laid my hat on the seat in church. When I picked it up at the end of the service I found considerable dust on it. I brushed the dust off, but on reaching home I found some remaining and noticed that it was yellow, so I examined it with a magnifying glass and found that it was nearly all pollen grains. Then I rubbed my finger across a shelf in my room and found it slightly dusty; the magnifying glass showed me that this dust was half pollen. This shows what a great amount of pollen is produced and discharged into the air, and it shows that very few pistils could escape even if they were under cover of a building."*

REVIEWS.

The First Book of Farming. By CHARLES L. GOODRICH. New York: Doubleday, Page & Co. 1905. 12mo. Pp. xx + 259. $1.00 net.

An admirable little volume just issued by Doubleday, Page & Co. The author says in his preface that the object of the book is to "assist farmers, students, and teachers in their search for the fundamental truths and principles of farming," and apparently he is destined to attain his object. He has succeeded in treating the subject in a popular way without detracting from the scientific value of the work, an accomplishment rarely attained in popularized scientific works.

The subject is treated in two parts; the first, under the title, "General Principles Underlying Plant Culture," in which the botanical side of the subject is taken up. The first eight chapters are given over, chiefly, to a discussion of roots and the relation of the plant to the soil. Directions for many simple and inexpensive experiments are given, and valuable advice is given in regard to the care of roots. The different kinds of soil and their relation to plant growth, temperature, and retention of moisture are explained and practical application of the principles indicated. The chemical composition and food requirements of the plant are discussed in a simple manner. In chapters IX. and X. are given suggestions for planting and seed testing. In chapters XI. and XII. the subject of ploughing and tilling the soil is treated in a way valuable to the experienced as well as to the beginner. Simple and detailed directions for the care of growing plants and the combating of insect pests are given in chapter XIII. In chapter XIV. the cause of the rise of sap in stems, which has so long puzzled the botanists, is treated in an easy, conventional way; and a discussion of the flower comprises the concluding chapter of Part I.

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* Goodrich, C. L., *The First Book of Farming,* pp. 132–133.

Part II. is titled, "Soil Fertility as Affected by Farm Operations and Farm Practices." In chapter XVI. the factors necessary to bring about a fertile soil, in the broadest sense of the term, are discussed in easily comprehended terms, though the author is unfortunate in the use of the term "germ" for bacterium. Chapter XVII. treats of soil waters in a manner which can not fail to be of benefit to the agriculturist and plant grower. "After Cultivation of Crops" considers the methods of caring for the soil after the crop is planted. Chapters XIX. and XX. deal with farm manures and fertilizers, especially with leguminous crops grown for fertilizers. Chapters XXI., XXII. and XXIII. should be of value to the farmer of eastern United States, as commercial fertilizers, their use and misuse, their composition, adulteration, etc., are discussed at some length. The two final chapters deal with the effect of different crops upon the soil and soil drainage.

The book will prove of value to the teacher, especially to the teacher in rural districts, as well as to the farmer and plant grower.

IRA D. CARDIFF.

A College Text-book of Botany. By GEORGE FRANCIS ATKINSON. New York: Henry Holt and Co. 1905. 12mo. Pp. xvi + 737.

This is the second attempt in this country to produce an advanced text-book in botany primarily for college use.* It is "the result of a revision and elaboration of the author's 'Elementary Botany,' New York, 1898." The general plan is practically that of the "Elementary Botany," with a division into five parts: I. *Physiology.* Here many chapters are unaltered, while some are revised and paragraphs added on nutrition and digestion written by Dr. E. J. Durand. II. *Morphology and life history of representative plants.* The subject of the morphology of fertilization in the gymnosperms and angiosperms has been revised "in order to bring this subject abreast of the discoveries of the past few years," and chapters are added on the classification of the algæ and fungi. III. *Plant members in relation to environment.* A study of the ecology of root, stem, leaf, and flower, followed by, IV. *Vegetation in relation to environment,* with "Suggestions for Practical Study of Plant Formations." This part has been entirely reorganized and rewritten. The section on "Annual Growth and Winter Protection of Shoots and Buds" is the work of Dr. K. M. Wiegand. Part V. deals with *Representative Families of Angiosperms.*

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* The other work is Campbell's "University Text-book," New York, 1902.

In these days of specialization it is a large task for one man to produce, alone, an advanced general text, and the specialist will probably be able to make adverse criticisms where his own line of work is touched. On the whole the different parts are treated with unusual equality of grasp. The book, of course, is quite beyond any high-school work, but will prove a valuable reference book, with which every high-school teacher should be equipped and familiar. C. S. G.

Experiments with Plants. By W. J. F. OSTERHOUT. New York: The Macmillan Co. 1905. 12mo. Pp. xix + 492. Preface by Professor L. H. Bailey.

As the name suggests, a guide to practical work in elementary plant physiology. The book is the most original recent treatment of the subject in English in point of experiments, simple devices, and manner of presentation. After an introduction, ten chapters follow on: "The Awakening of the Seed"; "Getting Established"; "The Work of Roots"; "The Work of Leaves"; "The Work of Stems"; "The Work of Flowers" "The Work of Fruits"; "How Plants are Influenced by their Surroundings"; "Plants which Cause Decay, Fermentation and Disease"; "Making New Kinds of Plants."

The work is hardly adapted for use as a text in the hands of the pupil, at least in eastern schools. This is not because of the nature of the book, but because of the character of the school course and equipment. Every teacher, however, will welcome the volume as a mine of helpful suggestion, and an incentive to better and more practical work. An excellent index makes the book doubly usable. C. S. G.

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HOW MUCH PLANT PATHOLOGY OUGHT A TEACHER OF BOTANY TO KNOW?

By Charles E. Bessey,
Professor of Botany, the University of Nebraska.

In answering this question I propose to suggest what I consider to be the minimum knowledge which he should have, and I shall bear in mind the limited time which every active teacher has for devoting to the special study of this subject. While it would be an excellent thing for him to know the subject thoroughly, everyone realizes that this is as impossible at the present as for every man to be an expert in regard to the diseases which are likely to afflict his own body. It is probable that we shall always need the advice of a physician however well informed we may be in regard to human pathology, and yet it is true that a man who knows something in regard to the nature and origin of diseases is more likely to avoid them than if he were totally ignorant in regard to them. And so it is with the diseases of plants. It is not likely that every botanist will become an expert plant pathologist, but he will be a much more helpful teacher of botany if he knows some of the main facts and principles as to plant diseases and their treatment.

Plants are Really Living Things.

What then are the things that the teacher of botany ought to know? First of all he should know fully that a plant is *a living thing*. I know that in a certain way we all think of plants as living, but very largely this is with some limitations and reservations. I remember the exclamation of a student in my laboratory, to whom I showed some unusually active low form of plant—"Why it's alive!" Yet I had talked and lectured to that student in regard to the life of plants, and all that I had said had not penetrated sufficiently to make him realize that life in the plant is like life in the animal. It was only when this life manifested itself in visible motion that its full meaning was understood.

Plants are alive, and their life is the same as that of animals. Not only is this true, but the life of a plant resides in the same substance in both kinds of living things. If we examine the animal substance under a compound microscope we find that it consists of very minute bodies which are composed of protoplasm—a soft and somewhat slimy substance. And so if we make a similar examination of the plant substance we find similar minute bodies, also composed of protoplasm. Now it is this essential identity of structure, and the actual identity of life, that I must insist upon here. The teacher who is trying to get an adequate notion of the pathology of apple trees, for example, must realize that they are actually alive as are horses and cattle, and that in their minute structure they are essentially alike.

Some Differences Between Plants and Animals.

Now while apple-trees and horses are essentially alike as living things, they differ in certain particulars. For example the tree has roots and leaves, while the horse has a mouth, a stomach, and blood-vessels. The digested food of a horse is carried rapidly to all parts of its body through a system of tubes—the arteries and veins—but in the apple-tree the food of all kinds merely *soaks* through the substance and has no tubes through which it runs. But in this the apple tree is like some lower animals, in which there is no system of arteries and veins, and as a consequence the digested food passes from part to part by a soaking process similar to that in the apple-tree. All animals having such a slow circulation are sluggish, some of them being almost as slow and sluggish as are the trees. It is noticed that just as animals are more active, their circulatory system is more perfect.

The slow circulation in plants implies slow progress in their diseases. In an animal a poison may be carried to all parts of the body in a few seconds or at most a few minutes, but in plants this is much slower on account of their want of a circulatory system. So it is with bacterial diseases which may pervade the whole body of the animal in a short time, but in the plant their dispersal through the body is very slow. Plant diseases are therefore slower and simpler than the corresponding diseases of animals, and this fact must be taken into the account by the person who wishes to know even a very little about plant pathology.

SOURCES AND CAUSES OF PLANT DISEASES.

In the second place the teacher of botany should know something as to the more common sources and causes of plant diseases. These are briefly as follows:

1. *Thirst,* which in plants as in animals is the condition of the body in which there is a deficiency of water. Plants need water for the same purposes as animals, the principal one of which is to keep the inner tissues wet enough so that they may do their work properly. But both plants and animals lose a good deal of water, and this loss is especially great in dry air, and for this reason there must be an extra amount to make good this loss.

2. *Starvation,* which is like that of animals, namely, the lack of a sufficient amount or kind of food. We know that to do well a domestic animal must have what we call a "balanced ration," that is, one in which all the constituents which are necessary to build up all parts of the body are present in proper proportions. Now it is just so with a plant: it must have a balanced ration also in order to do best, and if any of the necessary food constituents are wanting it will suffer from starvation. Plants growing out of doors never starve for the food constituents which come from the air, but they frequently suffer for want of some which they should get from the soil. Now and then a soil is deficient in nitrogen or phosphorus, or perhaps iron, and the plant suffers. In many regions there is a deficiency of potash or lime, or of still other constituents.

3. *Poisoning.*—This may be from gases in the air, which when absorbed by the leaves kill or injure their tissues. This is not likely to occur in the country, but it is common in and near manufacturing cities, especially so near smelting works, coke ovens, and like establishments, which emit chemical fumes in considerable volumes. A much more common source of poisoning is from the presence of harmful substances in the soil. Most trees cannot endure the presence of appreciable quantities of common salt, and when this occurs in the soil in sufficient amount they are slowly poisoned. So too the presence of "alkali" is harmful, as indeed is the case with many other soil constituents. It must be borne in mind that lime, magnesia, soda, iron, etc., very dilute solutions of which plants need or at least are tolerant of, when in strong solutions become fatally poisonous. In some cases the soil may be helped by the application of some corrective, but for the most part it will pay the tree grower best to make selection of a soil which does not contain any of these substances in poisonous quantities.

4. *Wounds.*—Attention has been called repeatedly to the injurious effects of wounds on trees; in fact they are comparable in their harmfulness to open wounds in animals. And just as in animals a wound is a place through which harmful bacteria may gain entrance to the body, so a wound in a tree allows various kinds of injurious organisms to enter the inner tissues. Every wound on a tree, from whatever cause, is a danger, and should be cared for, if the life of the tree is to be indefinitely prolonged. The most general cause of wounds is the wind, which breaks or twists the branches and often splits them badly. In the dense forests trees are rarely injured in this way, as they protect one another, but every isolated tree is especially subject to the power of the wind. Orchard trees are usually planted so far apart that they are exposed to almost the full fury of the wind, and after every storm many trees show many ragged wounds through which fungi of various kinds may enter.

Another fruitful source of wounds is the gnawing of the bark by rabbits and other animals. These wounds are not as deep as those due to winds, and yet they are often even more harmful, since they expose or destroy the cambium, and so stop the stem growth, often resulting in the early death of the tree.

The third class of wounds includes those made by the owner himself when he prunes his trees. In many cases he is wise enough so to handle his trees that he does not have to remove large branches, thus avoiding the necessity of making large wounds. But in too many cases the tree is allowed to grow as it will for a number of years, and then when too many branches have started the top is severely pruned, leaving many open wounds through which fungi gain entrance, and in which decay sooner or later sets in. If these wounds in the top are accompanied with wounds on the roots, due to careless transplanting, the tree is in a sad plight indeed. The wonder is that with so many gaping wounds the tree ever recovers. And there can be no question that these partially healed wounds are the cause of the early death of many a tree. Such trees are like the soldiers who have many wounds, from which they seem to recover for a time, only to find after a while that the old wounds which were only partially healed, finally drag them down to death. A wounded tree is like a wounded man; it may recover, but there is always danger that the wound is not fully healed, and may some day prove fatal.

5. *Loss of Necessary Parts.*—All things considered the leaves are the most necessary organs of plants, and yet the leaves are frequently destroyed so that the plant is naked. Now, the leaves are not the clothing of the plant, as is supposed by some people, but they are much more like the stomach, in which the food is prepared so that it can be used by the plant. A plant without leaves is in practically the condition of an animal which has no stomach. Of course this is a very crude comparison, but it is true to this extent that both leaf and stomach are necessary organs in the preparation and digestion of food, on the one hand for the plant, and on the other for the animal. When insects eat the leaves of a plant they destroy to that extent its power to use the available plant food, especially that derived from the air. And this is the real nature of the injury to a tree when its leaves are lost whether by insects, frost, hail or any other means. The

result is always the same, namely, the loss of the power of utilizing food. Such a condition is in fact one form of starvation, and the final result, so far as the plant is concerned, is the same.

Roots are sometimes destroyed by insects, moles or other burrowing animals. The principal function of roots is to absorb water and food matters from the soil, so that the loss of roots implies the loss of the power to absorb water and such foods as are in the soil water. A tree whose roots have been eaten off is in danger of dying from thirst as well as from starvation. But many trees suffer from the loss of their roots at the hands of man himself, when he digs them out in such a way as to cut off the roots close to the base of the trunk. A tree so mutilated is in as pitiable a condition as when it has suffered such a loss through other means. The mere fact that the owner of the tree has purposely cut off the roots does not help the poor tree. It is quite as likely to die from thirst and starvation as though the mutilation had been done by rascally gophers or moles.

Sometimes the flowers of apple trees suddenly die before the fruit has formed. Here the disease is confined to the reproductive organs, and while the life of the tree itself is not threatened, the crop of fruit is ruined. This disease is often due to a form of " blight," closely related to, if not identical with, the ordinary " blight" of twigs and leaves. In other cases it is due to the presence of small worms (larvae) which eat the soft tissues of the flower stalks and bases, killing the whole cluster much as in the case of the blight.

6. *Fungi.*—Here we come to the most fruitful causes of plant diseases. There are so many species of harmful fungi that every kind of higher plant is infested by at least several, and some are attacked by ten times as many. These affect plants in different ways, but for my present purpose I shall notice only the following modes: (*a*) Some grow over the surface of the leaves choking them so that they cannot perform their functions properly. A good example of such a surface fungus is the Powdery Mildew which often attacks the leaves of roses, verbenas, cherries, etc., covering them with a fine white powder. Every observing man knows that plants so affected cannot make a good growth.

The reason is that the leaves cannot make the necessary food constituents, and as a consequence the plant is partially starved.

(*b*) Another type of fungus grows on the surface of fruits, forming patches and blotches which are unsightly. The common Apple Scab is a familiar example of a fungus of this kind. It is a surface fungus, never penetrating deeply into the tissues of the apple, but producing such disfigurement as to seriously injure its market value. (*c*) Still another type of fungus is that which lives inside of the leaf tissues, killing small patches. Such are the many Leaf-Spot fungi, of which many species are known to be parasitic upon many kinds of trees. Now the damage done by fungi of this kind is directly proportional to the amount of tissue killed in each leaf. In case of the shot-hole fungus (which kills little round patches on the cherry and plum leaves—the dead patches soon falling out and leaving holes) I have seen leaves in which one-tenth of the tissue was killed, which implies that the leaves had only nine-tenths of their full power to make food for the use of the tree. This is equivalent to reducing the food of the tree by just that amount. (*d*) There is still another type of fungus which lives inside of some part of the tree and decays it. Such fungi are among the most destructive with which we have to deal, and unfortunately they are very abundant. Some of them enter the root where it is wounded, and penetrate and rot the wood, turning it into a soft, dry, rotten mass. Here is where the evil effects of mutilation of the roots are manifest. Where a tree has rotten roots it cannot secure a sufficient supply of water and food matters from the soil, so that it suffers from thirst and starvation, while at the same time it is liable to still greater injury by being blown over by severe winds. Allied to the fungi which produce root-rot, and possibly identical with them, are those producing stem-rot. They gain access through wounds, and penetrate the stem tissues, turning them into a mass of decay. Aside from weakening the stem, which makes them especially liable to injury in high winds, the trees so attacked show evidence of general thirst and starvation.

Many fruits are attacked by rot-producing fungi, as in the common apple rot, where a fungus gains entrance through some puncture or wound in the skin, and then penetrates all the tissues of the fruit, eventually turning the whole into a rotten mass.

GENERAL NATURE OF FUNGI.

It is not enough to know how a fungus acts in attacking a plant. While that is essential, it is by no means sufficient to enable the teacher to suggest means for eradicating it. He must know how and when it reproduces itself. Now every fungus at some time in its life produces tiny seeds (spores) so small that they are easily carried by the wind for considerable distances. No fungus comes spontaneously, any more than do weeds or grasses. Every one comes from a seed (in the broad sense) just as every tree comes from a seed. It is these minute seeds that blow from plant to plant, and from tree to tree, thus carrying the disease. Now it is a well established fact that every fungus is much more easily combated if taken when it first appears than after it gains full headway. It is with fungi as it is with weeds in your garden—you can kill them best when they are young, and it is a pretty difficult and tiresome thing to kill them after they are tall and pretty well rooted. It is important, therefore, that the grower of plants should know when and where the fungi begin their work on his trees and other plants, for this is the best time to spray with such a poisonous substance as "Bordeaux Mixture" in order to kill the largest number of fungi. Still another reason why we should quite certainly know when the fungi begin to grow is, that while we can kill them with a poisonous spray as long as they have not penetrated the tissues, when that is accomplished and they are safely inside of the leaf of the plant, it is quite useless to apply the poison. Here then is one of the most important points in this subject for the botanical teacher to know, and he should give as much time and thought to it as possible.

SOME FACTS ABOUT PLANT DISEASES.

Another thing to be remembered is that some plant diseases can be "cured," and many cannot. Thirst can be cured if the trouble is in the soil, and the roots are sound. So starvation can be cured by enriching the soil if the roots, stems and leaves are in good condition. Mild cases of poisoning can be cured, but severe cases invariably prove fatal. Wounds that have been neglected are incurable, but if treated properly when first formed, they may generally be made to heal quickly and effectively. The loss of necessary organs is not necessarily irreparable. New leaves will sometimes appear after they have been destroyed by insects or other causes: roots will often push out to take the place of those which were cut off, and even flowers which have been destroyed may be replaced by a later set if the tree is in vigorous condition. On the other hand diseases due to fungi are generally incurable in any proper sense. An internal leaf fungus cannot be eradicated when once it is inside of the leaf, and so a fruit-rot or a stem-rot cannot be remedied. In such cases prevention is all that can be accomplished. We can prevent the fungus from getting into the leaf, stem or fruit, but when once it is inside it is safe from any sprays or other remedial measures which we can employ against it.

AVOID QUACKS.

The last thing to which attention should be called in connection with this matter of plant diseases is that here as elsewhere there are quacks to be avoided. There are all sorts of patent medicines advertised for curing all sorts of plant diseases. Now these things are just like the patent medicines which fill so many yards of shelving in the drug stores in every town,—they are *made to sell,* and to bring money into the pockets of the makers of the medicines. My advice to every plant grower is to refuse absolutely to buy any of these advertised remedies and so-called "plant invigorators." When you are sorely tempted to buy a cure-all for your tree troubles write to the botanists in the Agricultural Experiment Station of your State, and they will give you the best advice available, and not charge anything for it, either.

A BRIEF HISTORY OF ECOLOGICAL WORK IN BOTANY.

BY HOWARD S. REED,

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(*Conclusion.*)

In the next decade in Germany we see the beginning of much valuable ecological work.

A mass of careful observations are recorded by Dr. Hermann M. Muller in a book published in 1873 entitled *Die Befruchtung der Blumen,* or The Fertilisation of Flowers by Insects. His observations cover much the same ground as did those of Sprengel eighty years before, but he treats the mechanisms of flowers from the standpoint of natural selection instead of teleology.

In the same year there appeared Hildebrand's book upon the Modes of Dissemination of Plants. The author was professor of botany in the University of Freiburg. His book remains to this day the only scientific study of seed dispersal, although there is much to be gained from an investigation of the subject with modern histological methods.

In the period between 1876 and 1880 we find the first papers from two German botanists who have done much for the study of plant distribution, Oskar Drude and Adolf Engler. The most of Drude's publications have appeared since 1884 and his *Handbuch der Pflanzengeographie* was published in 1890. Drude is now professor of botany in the Technische Hochschule in Dresden. Engler is professor in the University of Berlin, and during the past twenty-five years has contributed many valuable monographs on the classification and distribution of plants. In conjunction with Drude, he is now issuing Die Vegetation der Erde, a work which contemplates nothing short of a description of the flora of the earth, according to the natural divisions.

The work of these two men may be said to mark the beginning of the study of phytogeography by a school of ecologists who traveled extensively through the tropics and temperate zones, studying the deserts and tropical forests. Since 1884 we have had numerous monographs each year on the flora of the less well known regions of the earth. Among the more prominent men in this school may be mentioned Johow, Volkens, Schimper, Schenck and Krassnoff.

Professor Schimper, of the University of Basel, performed a lasting service by gathering the observations of many plant geographers and publishing them along with his own in his Pflanzengeographie which appeared in 1898. The book shows what had been done toward a complete study of the plants of the world up to the date of its publication. It also shows what large gaps there are in our knowledge as well as the difficulties to be met and overcome in accounting for some of the common facts of distribution.

Schenck began a line of work to which modern ecology has recently turned. Leaving to his colleagues the task of traveling to distant lands, he took up a careful biological study of the plants near at hand. In 1885 he published his observations on the Biology of Water Plants which gave an admirable account of the common aquatic plants. He dealt with such subjects as the anatomy of the submerged organs, the wintering of the plants, the germination of the seeds, etc. Up to that time plant geographers had paid little attention to the study of adaptation. Schenck's work showed the value of such study for ecological work. In these days when landscape photography is so often made to pass for patient, accurate study, it is worth while to notice that the perspicuity and exactness of Schenck's descriptions rendered few illustrations necessary. His work moreover ranks fully as high as that of his colleagues on the plants of regions which most of us never have, nor will, visit.

Attention should also be directed to the studies of plant adaptation carried on from an experimental point of view by Stahl, of Jena, and Vöchting, of Tübingen. Each year witnesses an increasing appreciation of experimental work in ecology, and the science will have gained much when experimental work is the regular thing, not only in the laboratory but in the field.

Professor Goebel took up the study of morphology as correlated to function and environment. He has given us in his Organography of Plants and his *Pflanzenbiologische Schilderungen* an accurate determination of facts and factors upon which many previous students had wasted much time and ink in speculation. Goebel put spirit and life into the dry bones of anatomy as studied by de Bary and Schwendener. The experimental morphology which he has opened up must be the solution of many future ecological problems.

In France we have seen that a Phytogeography of Europe was published in 1855 by Alphonse De Candolle. In 1878 Vesque began the publication of his investigations upon the influence of environment upon the form of the plant. About the same time, Bonnier began his valuable studies on Alpine plants, and later worked in conjunction with Flahault who has given particular attention to the physical factors of the environment. The work of Constantin which began in 1883 is along a similar line. Jaccard, of Lausanne, Switzerland, may also be included in this list of French ecologists, because his methods and work are largely the same as theirs.

For many years the Scandinavian botanists have studied plants in their relation to environment and have given us some of the most valuable information we possess concerning the plants of northern Europe. It may be noted that they have studied the ecology of the algae and their distribution in the plankton. This calls attention to the fact that, strange to say, almost all ecological studies have been upon the higher plants. There is unquestionably a rich field for study in the lower plants, and especially among the fungi, in the investigation of such topics as the penetration of host plants by parasites, the relation of saprophytic fungi to the nature of the substratum, the ecology of facultative parasites and saprophytes, etc.

We owe to Professor Warming, of Copenhagen, more than to any other, the conception of the plant society; an idea implying the existence of an organic unity among the plants. In his Text-Book of Ecology he took up and worked out the classification of plant societies according to the water content of the soil; a relation which seems to have been originally pointed out by Schouw in 1823. Warming realized as probably Schouw did not, that a grouping based upon a single factor could never be a permanent one. He points out that the factors of the environment are largely mechanical and have aided, but not determined, the development of the physiognomy of the plant society.

Besides the name of Warming, we have those of Kjellman, Areschoug, Wittrock and many others who have made the botanical literature of Scandanavia largely one of ecological observations.

Concerning the work of the last ten years in Europe time will not permit one to speak specifically. A large amount of work is done every year; it is too early to pass judgment on its ultimate value. Work like that of Warming, Goebel, and Bonnier will endure. Progress is being made every year, but there still remains much to be done.

The first extensive study of the flora of North America seems to have been made by Andre Michaux, who between the years 1785 and 1796 explored the country from Hudson's Bay to Florida and westward to the Mississippi. We may well marvel at the completeness of his studies when we remember the difficulties he encountered. Most of the region he visited was an unbeaten wilderness where the best of roads were mere bridle-paths and travel was endangered by the hostile Indian tribes. We are indebted to Michaux for a study of the flora of the eastern United States before it had been modified by the white man. His description of the North American flora, published in 1803, was based entirely upon his own collections and does not contain any plants which he had not himself gathered or seen.

Eleven years later, namely, in the year 1814, the second Flora of North America appeared from the hand of Frederick Pursh. This flora was not confined to the author's own collections but aimed to give a complete description of the plants of North America, so far as they were then known. He included in his flora descriptions of about one hundred and fifty specimens gathered by Lewis and Clark on their return from the Oregon territory.

Botany did not become a science in America, however, until the time of Asa Gray. He began his botanical work with John

Torrey along systematic lines, but his extensive knowledge of plants led to special studies of the problems of distribution and adaptation. Early in his career Gray won the friendship and confidence of Darwin and later became one of the chief exponents of the theory of natural selection in America.

Gray's memoir, published in 1859, on the botany of Japan in its relations to that of North America fixed the attention of the world on him as a philosophical naturalist. It showed that he could make excursions into the realm of ideas as well as that of plants.

Among other essays which deal with ecological subjects were the following: Do Varieties Wear Out or Tend to Wear Out?; Forest Geography and Archaeology; The Pertinacity and Predominance of Weeds; The Characteristics of the North American Flora. In addition to the well-known Manual, Dr. Gray planned and started the Synoptical Flora of North America which has since been carried on by Watson and Robinson.

The importance of the work which Torrey, Gray, Watson, and Coulter did for ecology was in describing and systematizing the plants of this country. Upon this foundation all subsequent work in plant distribution and physiographic ecology rests.

We are indebted to Engelmann not only for a classification of several difficult groups, *e. g.*, the conifers and oaks, but also for a knowledge of the habits of some of our western plants. As examples of the latter, we may mention his monograph of the yuccas published in 1873 describing the symbiotic relations of the plants with the insects which pollinate their flowers. Engelmann was a physician of large practice in the city of St. Louis who spent much of his time in the pursuit of botany. It is related that he even busied himself drawing cacti while diagnosing the cases of his patients.

American botany has produced several important monographs on the flora of particular regions.

Chapman's Flora of the Southern United States was one of the first of this class, both in point of importance and of time. The first edition appeared in 1860, and a second revised edition in 1897, just two years before his death. It will always remain a noteworthy contribution to the knowledge of our plants, representing the results of fifty years' collecting and study. It was followed by another valuable piece of work upon the flora of Alabama by Dr. Chas. Mohr, representing the results of forty years' study. The book includes a discussion of the plant societies of the state as well as the general physiognomy of the flora.

There are numerous other monographs dealing with the flora of particular regions, but time and space will permit only the mention of a few: Lindheimer, Plants of the Mexican Boundary; Coulter, Manual of the Rocky Mountain Region; Coulter, Botany of Western Texas; Watson, Botany of California; Howell, Flora of the Northwestern United States; Britton, Flora of New Jersey; Beal, Flora of Michigan; Millspaugh, Flora of West Virginia; Dudley, The Cayuga Flora; Brainerd, Jones and Eggleston, Flora of Vermont.

Such observations as the above, if carefully made, are worth much for the student of plant distribution. By an extension of this work the time is drawing near when we shall have the material necessary for a comparative phytogeographical study of the entire country.

A large and noteworthy contribution to the botany of this country was made by Coville in his study of the flora of Death Valley, California. Although most of the work is from the standpoint of the systematist, yet it gives us a picture of xerophytic plant life and the conditions it has to meet.

The Phytogeography of Nebraska was the subject of an extensive and interesting study of the plant life of that state by Pound and Clements. It is an attempt to study the distribution of plants in that state, not according to localities, but according to factors of the environment. Notwithstanding more or less of imperfection it represents some of our best work in recent ecology. The ideas first presented there are now being worked out with more completeness by Dr. Clements in his studies on the vegetation of the Rocky Mountains in Colorado.

The problems of succession and invasion on sand dunes and in river valleys have been studied and very completely described by Cowles. His work is important in bringing out the dynamic relations of different societies.

More recently Ganong has given an excellent description of plant societies and their interrelations on the salt marshes of New Brunswick.

Concerning the ecological work in America in the last few years it is still too early to give an estimate. There have been many workers in the field, some of them venturesome, others cautious, and all of them have perhaps erred in trying to draw conclusions from work based on too few observations. Some of their ideas will undoubtedly live, others will not.

The establishment of such laboratories as that of the Carnegie Institution at Tucson, Arizona, and of the New York Botanical Garden at Cinchona, Jamaica, are signs of a movement in the right direction. No less important, for the progress of ecological study, is the spread of botanical laboratories throughout the country as a concomitant of the growth of universities and colleges in the last twenty-five years. From places like these we may expect observations from resident investigators which will replace those of the hasty midsummer vacation trip. They will be able to put their work upon on experimental basis.

When we look back over the ecological work which has been done in America we must admit that, at best, it makes a poor showing. In the first place, the botanist has a hard task before him because our flora is very large and very diverse. The absence of barriers in the central and eastern parts of the continent admits of extensive dispersal resulting in a heterogeneous flora. Possibly the desire to explore regions unknown, botanically, has kept some men from the less inviting task of accumulating biological data. Certain it is that until the last few years we have had little but studies of distribution from the field worker. Again we must admit that, as a whole, our ecological work displays but little originality or creativeness and that some of it is a poor imitation of work done on the other side of the Atlantic. This may be partly due to the fact that we have as yet no great schools of ecology in this country which give the best of their energy and time to ecological botany. Then too it must be acknowledged that our students who attend European institutions generally go to the *savants* of morphology and physiology, while only a few catch the ideas and methods of the workers in ecological lines.

Finally, our work has suffered at the hands of those who undertook it without sufficient foundation knowledge to enable them to interpret intelligently the biology of the plant in its habitat. He is a well trained and cautious observer who can perceive the agencies which mould the structure or habits of a plant growing in its native environment; not all skilled laboratory workers do it successfully when they go to the field. But the field worker must, above all else, be familiar with the morphology and physiology of the plant through the laboratory method; for unless he perceives the various activities by which the plant maintains its existence and bodily form when he can, in a measure, isolate them in a laboratory, he will be less able to do so in the field. It is gratifying to know that the former practice of theorizing is giving way to experimental field work; for it indicates that the workers realize that practically all ecological studies are ultimately physiological.

By way of giving a general view of the ecological work in botany of the last hundred years, the writer has divided it into three periods. They are not, of course, sharply marked off from each other; but they are intended to show certain manifest tendencies in the work.

PERIOD I. 1803–1859. A study of the distribution of plants based on the laws of meteorology and temperature control.

PERIOD II. 1859–1885. Two distinct tendencies appear in this period which may be designated—

(*a*) *Biological.* The adaptations of plants for pollination, capture of prey, seed dispersal, etc.

(*b*) *Distributional.* The study of plants on the earth according to the conditions of the natural divisions.

PERIOD III. 1885 to the present. The study of the adaptation of the plant to its internal and external environment. The physiological response to the complex of factors operating upon the plant.

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THE COWTHORPE OAK.*

There is probably no living tree about which so much has been said and written as about an oak at Cowthorpe, near Wetherby, in England. It is larger in diameter than any other oak of which there are records. For more than two centuries it has held its place as king of oaks. From time to time during that period it has been measured and described by scientists who have left their descriptions.

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* Clayton, J., Trans. and Proc. Bot. Soc. Edin., **22**: 396. 1904.

The earliest data which we have was taken by Dr. Hunter about 1700. He gave the circumference on the ground at 78 feet and the height as 80 feet. As the process of decay has gone on the tree has shrunk and settled into the ground somewhat, so that in 1893, according to John Clayton's measurements, its girth was only 54 feet and three inches. The top main branches had died and been torn away by the wind and the center of the trunk had decayed, leaving a cavity of 9 by 13 feet. It still bears leaves and fruit but now the work of decay is so nearly accomplished that it seems impossible for the tree to survive much longer.

The age of the Cowthorpe Oak has been a subject of great interest and speculation. Before the middle of last century De Candolle's theory that trees never die of old age but would live forever if they could escape injury and disease was widely accepted. He studied sections of a great many trees and decided that the average growth of any species could be determined by measuring the annual increase in diameter. By this system he estimated the rate of growth for the oak to be one-twelfth of an inch each year. While this theory was prevalent the age of the Cowthorpe Oak was computed by it and found to be 1600 years. This is the age which is generally accepted for the veteran tree.

If the age of other large oaks cut while still sound be estimated by this theory and then be determined by a careful counting of the annual rings it will be found that facts do not sustain the theory. The yearly growth of a certain tree cannot be determined from the average growth of the species because no two individuals grow alike and even the same tree increases more rapidly in some years than it does in others. Young trees grow faster than old ones. This cannot be accounted for by saying that as the tree gets larger the area is greater in proportion to the diameter, because it often happens that for a long period of years the annual rings will be of about the same width in spite of the increase in area. As the tree grows old they gradually become narrowed.

An explanation for this is that as the young trunk grows the branches lengthen, bearing more twigs which would increase the leaf surface, thus the tree would be able to lay down more tissue to meet the increase in size. When the tree becomes old the leaf-bearing twigs become fewer and fewer, the topmost branches gradually dying. As the leaf surface decreases less food is made so the annual rings become narrower until growth stops and the tree is dead. Thus we see that there are three periods in the life of a tree, the first while it is increasing in all directions, the second while it remains almost unaltered and the third is its period of decay.

This proves that the De Candolle's theory is false and that the age of a tree cannot be determined by ratios. The sixteen-century belief is untenable, but some idea of the age of the Cowthorpe Oak may be gained by comparing it with other oaks whose age is known and by considering as much of its life as has been recorded.

The large oaks at Castle Howard growing under the most favorable circumstances and known to have been planted early in the eighteenth century, have entered the period of decline. Others nearby which were in their prime when these were planted are now in the state of the Cowthorpe Oak. Judging by these trees we shall find that oaks under favorable conditions will live 350 or 400 years. It seems absurd to ascribe 400 years as the duration of the life of the Cowthorpe Oak which for more than half a century has been regarded as nearly as old as the Christian era, but this is about the term which trustworthy evidence warrants.

The rapidity of the decay of the tree also points to the shorter term of life. Pictures of the tree as late as 1776 represent it as sound and it was not spoken of as being otherwise till many years later. This allows only a century and a quarter for the decay of the tree. From these facts it seems that 500 years is the longest period that can reasonably be assigned as the age of the tree. Popular convictions are hard to eradicate and, for many years to come, the old tree will probably be described as having lived sixteen centuries. S. G. S.

AN INDIAN MAGNOLIA IN AMERICA.

By H. Nehrling.

In Sir Joseph D. Hooker's famous book, Himalayan Journals, we find the following short but highly interesting account of this beautiful evergreen magnolia:

"Scarlet flowers of *Vaccinium serpens,* an epiphytal species, were strewed about, and the great blossoms of *Rhododendron Dalhousiae* and of a magnolia (*Talauma Hodgsoni*) lay together on the ground. The latter forms a large tree, with very dense foliage, and deep shining green leaves, a foot to 18 inches long. Most of its flowers drop unexpanded from the tree, and diffuse a very aromatic smell; they are nearly as large as a fist, the outer petals purple, the inner pure white."

And in the beautiful hand-colored edition of his Illustrations of Himalayan Plants the same author gives the following description:

"This is not an uncommon plant in the Sikkim forests, as at Khersiong and below Labong, where it grows close to the roads, forming a small tree 20 to 40 feet high, flowering in April, and always densely clothed with its large, handsome, coriaceous, evergreen leaves, which attain a great size in young plants. The flowers are very fragrant and aromatic; though they do not expand much, they are exceedingly handsome, from the rich plum-bloom on the purple outer sepals, contrasting with the ivory whiteness of the inner ones; all the pieces of the flowers are thick, hard, and fleshy."

"*Talauma Hodgsoni* flourishes in a stiff clay soil, as do almost all the Himalayan Magnoliaceae, and would require to be grown in a conservatory heated in winter."

These accounts created such an enthusiasm in the writer that he at once wrote to Darjeeling for seeds and to Dr. J. D. Hooker for further information. Mr. Wm. Kennedy, the director of the Botanical Gardens at Darjeeling, was kind enough to send me seeds, not only of *Talauma Hodgsoni,* but also of *Michelia* (*Magnolia*) *excelsa* and *M. Cathcartii,* two other famous magnolias. April 2, 1898, the seeds arrived and were planted immediately in a mixture of two-thirds of Yadoo fiber and one-third crushed charcoal.

The seeds had scarcely been planted when a letter from Mr. Hooker arrived, which contained the following important passage:

"With regard to seeds, you are perhaps not aware, that they do not bear intertropical transportation. When director of Kew I received packets of these seeds over and over again, but not one ever germinated; the reason being the rapid decay of the albumen, involving that of the embryo. Such plants as these may be at Kew were all received in Ward's cases, through the intermediacy of the Royal Botanic Garden of Calcutta. They had been planted in the cases in the Himalaya and sent by rail to Calcutta and so to England,—very few surviving."

"By offering a sufficient inducement you might possibly have a Ward's case filled with young plants in Sikkim and transmitted to an agency in Calcutta, to be forwarded to England, where they should be nursed before transmission to America—but I need not say that the expense would be heavy, and the risk of failure very great indeed."

After reading Mr. Hooker's letter all my hope of raising plants from the seeds which I had received from Mr. Kennedy vanished and I almost forgot about them. About four weeks after planting the seeds I was one morning surprised to find a few strong young plants in my seed pans, looking very much like weeds, piercing the surface of the soil, and a few days later there could be no doubt that one plant was *Talauma Hodgsoni* and the other *Michelia excelsa.* Both grew rapidly, but the latter was killed by too much kindness, while the other survived even this and formed in time a beautiful healthy plant with immense foliage of a deep bluish green color. When about six inches high I transplanted it in a small pot in rich light soil and in the fall of 1901 it had attained a height of over two feet, growing then in a six-inch pot. I intended to send the plant down to Florida to be set out in the open on my place, but being aware of the fact that this was the only specimen of its kind in this country, I though it too valuable to risk its culture out-of-doors, and for this reason I sent it to my friend, Dr. Wm. Trelease, director of the Missouri Botanical Garden, where it now flourishes vigorously, and where it will be planted out as soon as the necessary room can be afforded. In Kew there is a very beautiful large specimen flowering annually and diffusing its delicious fragrance through the large temperate house where it is growing.

REVIEWS.

The Journal of Agricultural Science is the name of a new magazine the first issue of which appeared on Jan. 26, 1905, from the University Press, Cambridge, England. The purpose of the Journal is to serve as a medium for the publication of original papers in any science so long as they bear on agriculture. The subscription price is $4.50 the volume, single copies $1.50. The Macmillan Co. are the American agents.

A Key to the Genera of Woody Plants in Winter. By K. M. WIEGAND and F. W. FOXWORTHY. Ithaca: Published by the authors. 1904. Pp. 27. 25 cts.

This little pamphlet is the only work of its kind in English that treats of cultivated as well as wild forms, and includes "those with hardy representatives found growing wild or in cultivation within New York state." In this manual a rather difficult task has been exceedingly well done, and it will be a welcome addition to existing artificial keys. C. S. G.

How to Know Wild Fruits. By MAUDE GRIDLEY PETERSON. New York: The MacMillan Co. 1905. Pp. xliii + 340. $1.50 net.

This book fills a hitherto unoccupied niche in popular botany. Amateurs have at their disposal a large number of books for the identification of plants by their flowers. By the use of Wiegand and Foxworthy's little manual trees and shrubs may be determined in winter when both flowers and leaves may be wanting. Miss Peterson's book is "a guide to plants when not in flower by means of fruit and leaf." The plant families are arranged according to Engler and Prantl. Seven pages of the ecology of fruits and seeds, one page of definitions and a key of 26 pages are followed by detailed descriptions accompanied by illustrations in black and white. A glossary and indices of English and Latin names add to the usableness of the book. It will be welcomed by many teachers and others interested in knowing plants. C. S. G.

Manual of the Trees of North America. By C. S. SARGENT. 8vo. Pp. xxiii + 826. Illustrated. $6.00 net. New York: Houghton, Mifflin and Co.

The form in which Professor Sargent's extensive studies of the tree vegetation have appeared has hitherto been such as to preclude its possession by any but those exceptionally well fortified with purchasing power. The results of the author's wide experience are now for the first time available in a compact volume. The typographic achievement is the more marked when we consider that each of the 630 species described is illustrated by a more or less elaborate line engraving. Much of the space thus occupied might however, we regret to say, have been put to much better use. We cannot convince ourselves that the many drawings of *e. g.* the supposed numerous species of *Crataegus,* will be of any more use than to break up the monotony of octavo pages of small type. Certainly they will not help the novice, and will as certainly be ignored by others.

The treatment appears to the reviewer rather uneven. The genus *Cretaegus* has been a matter of much difference of opinion as regards the number of species it may contain, and at this time in the development of taxonomy, it ill behooves one to take any but a position of stolid skepticism. But we feel very safe in saying that if *Crataegus* has 132 species, the genus *Acer* certainly has more than nine, a genus which moreover has far more than its share of varieties. This, however, is as much as to say that our present day taxonomy is but a step to a more exact science of the future, the goal of which we may now see but dimly if at all.

Concerning the cacti, which the author, in part, includes, we may very well ask if they are trees at all. On the author's supposition, there are several, if not many, more, than are accredited as trees. As to their common names we would take exception to "Suwarro," since the spelling is not in accord with the pronunciation, which, indeed, is difficult for the English vocal apparatus. But since "Cholla" is not spelled adaptively in this regard, why should "Suwarro" be so treated?

Professor Sargent has, however, done a large piece of work, and his manual will, no doubt, be of much value to students especially to foresters and those interested in trees in particular. The analytical key at the beginning of the work is based upon leaf characters. The publishers are to be congratulated on the appearance and compass of a book containing such a very large content.

The Book of Garden Design. By CHARLES THONGER. 12mo. Pp. viii + 87. Illustrated. London and New York: John Lane, The Bodley Head.

This book, in contrast to many treating of outdoor subjects, may well be regarded as a scholarly treatment of a subject which would in the ordinary scarcely receive such. There is much in it to stimulate the application of thought to gardening, and in a land where very few people do more than raise "garden sass," where few bestow that intimate attention to their own bit of ground of which we see so much in many other countries, such books as these are worthy of reading and study.

A Primer of Forestry. Part II. Practical Forestry. By GIFFORD PINCHOT. 12mo. Pp. 88. Washington: Government Printing Office. 1905.

An excellently illustrated and useful manual which will prove especially valuable to teachers who desire to introduce practical forestry into the school, while of use to those who own or are interested in forests from any point of view.

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OUTLINES FOR THE OBSERVATION OF SOME OF THE MORE COMMON FUNGI.

BY PROFESSOR GEORGE F. ATKINSON,

Cornell University.

These outlines have been prepared for the PLANT WORLD at the suggestion of Dr. C. S. Gager. They are not intended as a guide to the thorough and scientific study of fungi, but are designed more for the purpose of aiding in the observation of these interesting and curious plant forms, so far as this can be done for persons having no technical knowledge of the subject and having no aids in the way of microscopes more than perhaps now and then a pocket lens. It must be understood that with the general outlines here given, species, or in many cases genera even, cannot be accurately described. In many cases the description will answer for several species and for the purpose of study any one of several closely related species will answer. But it is hoped that they may serve the purpose of stimulating some to make careful observations and to increase the interest in out-door life by widening the range of forms of life with which one may come into conscious contact.

THE BLACK MOLD.

One of the black molds is often very common on decaying vegetables or fruits, or on old bread. It is often obtained in the following way. Cut a lemon or orange in halves. Squeeze out the juice. Allow the rind to lie for a day in an occupied room.

Then place it in a tumbler with a little moist paper in the bottom and cover with a piece of glass to keep the air in the tumbler moist. In a few days several molds will probably be growing on it. If there is a black one it is probably the black mold desired. Place some pieces of stale bread in a pan with some moist paper in the bottom, moisten the bread slightly and with a needle or small instrument plant some of the black spores from the orange or lemon on the bread. Cover the pan with a glass or another pan.

In a few days note the white mold growing over the bread. With a hand or pocket lens examine this and observe that it consists of very delicate, branched, white threads. This is the *mycelium* of the fungus. Nearly all fungi (except some of the very low ones, and some very specialized forms) have a mycelium. It is the *vegetative* or *growing* part of the fungus as contrasted with the fruiting parts.

In a few days, the fungus will become black. This is due to the development of numerous, dark, rounded and very minute bodies called *spores,* which are formed in a round spore case (sporangium). These spore cases are very numerous and are formed on the end of erect fruiting branches of the mycelium. When the culture is quite old the fungus is apt to grow off from the bread onto the sides of the pan. Now with the hand lens examine the spore cases and the fruiting branches of the mycelium where they are on the sides of the pan. Note that several of these fruiting branches, each bearing a spore case, arise in a cluster from the same point. Probably at the base of the fruiting branches a cluster of minute dark " rootlets " will be seen. By noting carefully it will be seen that a " runner " or single thread extends from this cluster a short distance to where another cluster is formed, and then on to another, and so on. In this way the fungus extends itself over the sides of the pan, or other substratum on which it is growing, somewhat as a strawberry " runner," or the " walking " fern, travels over the ground.

The spores in the spore case are easily set free, and are carried in currents of air to other places where they start more mycelium.

This is the way this and many other molds and other fungi spread, *i. e.,* by the formation and distribution of spores.

The Downy Mildews.

These are parasitic on many cultivated and wild plants. That is, the mycelium grows in the tissues of the plant (the host) and uses some of its substance for food, thus causing a disease from which the host suffers or dies. Thus the powdery mildew of the grape (*Plasmopara viticola*), the onion mildew, the potato blight, etc., are diseases of these plants caused by different species of downy mildew. The mycelium grows for example in the tissue of the leaves, forming irregular yellowish spots on grape leaves, and often giving a pale yellowish tint to onion leaves.

Examine with a hand lens the under surface of these spots on a grape leaf. If this fungus is present and fruiting the spot will be seen to be covered with a delicate downy growth formed of branches which come from the mycelium inside of the leaf. These are the fruiting branches (or conidiophores) which bear oval spores or conidia. These conidia are the summer spores and are carried by the wind to other leaves. Here in dew or rain they germinate by sending out a delicate thread-like growth which enters by a stoma into the leaf and forms more mycelium and more disease. In the late summer or autumn the internal mycelium forms another kind of spore, a winter or resting spore, which carries the fungus through the winter and starts its life again in the spring.

The White Rust.

The white rust (*Cystopus candidus*) is very common on the shepherd's purse. The mycelium grows in the leaves, stems and fruits, and forms cushions or masses of spores underneath the epidermis which by crowding burst the epidermis and set the spores free. With a lens examine these spots and note the ruptured epidermis and the mass of white spores. These are summer spores. Winter spores are formed which are similar to the winter spores of the downy mildews, and in fact these two kinds of fungi are closely related.

The True Rusts.

The true rusts are also parasitic fungi. The mycelium grows in the tissues of many cultivated and wild plants. Here and there it forms cushions or cups containing spores which are somewhat yellowish, or orange, or reddish, or brown or black, in color, according to the stage of the fungus or the kind.

The wheat rust (*Puccinia graminis*) is one of the common ones, and many persons are, of course, familiar with its appearance. It has a very interesting life history since it appears in a number of different forms which at one time were supposed to be different kinds of fungi. These forms are as follows:

The red rust form (uredospore stage). This occurs throughout the summer and often does great damage. Examine with a lens affected stems and leaves. Observe the ruptured epidermis where the cushions of spores are formed and note the spores which appear as a yellowish powder or granular substance. These are summer spores and serve to spread the disease since wind carries them to other plants. Here they germinate and the mycelium enters at a stoma and forms another crop of red rust spores and so on through the season.

The black rust form (teleutospore stage). This form often occurs later in the season, or as the grain is ripening. Examine with a lens and compare with the red rust. The spores of this form are winter spores and live through the winter. In the spring they germinate and produce on a short mycelium a third form of spore, the sporidium. This is minute and light and easily carried by the wind. One of the singular things about the wheat rust and others of its kind is that these sporidia cannot infect the wheat plant and produce the disease (in some rust diseases whose life history is different the sporidia can infect the same kind of host) but they can produce a disease in another kind of host.

The cluster cup form on the barberry. The sporidia from the black rust form germinate on the barberry and the mycelium enters a stoma where it spreads in the leaf tissue forming a diseased, yellowish spot. When this form is mature examine with a lens the spots on the upper surface of the leaf. Note the numerous minute yellowish or sometimes blackish pimple-like elevations. These are the spermagonia and contain minute bodies whose function is not known. Now examine the lower surface. Note the minute cup-like bodies, describe their appearance, their arrangement, and note the spores in them which scatter on the leaf surface. These are spring or early summer spores. The wind carries them to the wheat where they produce the red rust form again. It has often been observed, also, that very soon near the barberries the black rust form quickly appears after infection from the cluster cup spores and often in great abundance.

These four forms make the complete life cycle of the wheat rust form. Some rust fungi have only three forms in a life cycle, some only two, and some only one.

The cedar rust (*Gymnosporangium macropus*). There are a number of different cedar rusts. The cedar rusts have three forms in their life cycle, the cluster cup, the spermagonium, and the teleutospore stage. The latter occurs on the cedar, the two former on the leaves and fruit of apple trees. On the cedars the disease takes the form of large galls an inch or more in diameter, known as " cedar apples." Collect some of these in the autumn or winter. Note the size and form; observe minute pits at quite regular intervals over the surface. Describe carefully the appearance of these pits. In the spring during May when the warm spring rains come observe these " cedar apples." Note the long tapering gelatinous orange strings which exude from the pits. These contain the teleutospores which in Gymnosporangium germinate immediately and form the sporidia. These sporidia are then wafted to the apple where they produce the cluster cup form. Obtain some of the leaves of apple with the cluster cup, compare with that of the cluster cup of the barberry.

THE SMUTS.

These are parasitic fungi common on wheat, oats, barley, corn, etc. When the fungus is ripe there are numerous dark spores formed in large masses which have a black smutty appearance. Discover what parts of the wheat, oat and corn are affected.

Describe the appearance of the smut on each, especially on the corn in different stages.

PUFF BALLS.

Every one probably knows what puff balls are. They grow on the ground or more rarely on rotten wood. A few species grow on the bark of trees. Observe different kinds, some small and some quite large. Describe the form of the different kinds observed, and the character of the outer surface. Note also the external difference between the nearly ripe and the very ripe plants. Cut open young ones and compare with the interior of ripe ones. How are the spores disseminated? Puff balls are not poisonous if selected when they are white inside.

EARTH STARS.

The earth stars (*Geaster*) are puff balls of a special kind. The outer part of the wall splits in the form of a star and curves back on the ground or below the plant itself. Compare different ones as to size, shape, the number of the divisions of the " stars," the difference in the character of the " mouth " of the inner wall, etc. Place some of the dry ones in water and note the results. Remove and dry again.

THE AGARICS (FAMILY AGARICACEAE).

These all have a cap, on the underside of which are narrow plates or " gills " in shape something like a knife blade which radiate from the stem, or point of attachment of the cap to wood, etc.

The Common Edible Mushroom (*Agaricus campestris*). This grows in pastures, lawns, on roadsides, and sometimes in cultivated fields or meadows. The plant is two to four inches high, the cap two to four inches broad, the stem has a thin membraneous collar (the ring or annulus), the cap is white or, in some forms, gray or even light brown. The gills are first pink, then brown, and finally black. Note the color of the cap, and whether it is smooth, or scaly, etc., the thickness of the flesh, the odor and taste when fresh. Search for specimens in different stages of growth to see the difference in color of the gills. In the younger plants search for the " veil " and determine, if you can, how it is formed, and what becomes of it in the mature plant. See if you can determine what causes the change in color of the gills from the young to the old plants. In plants where the gills are becoming brown cut the stem off from two specimens, placing the caps gill side down on white paper. Cover one of them with a tumbler or cup to prevent the movement of the air. In ten to twenty hours observe the effect on the paper. It is colored by the spores. Are the spores easily wafted about by currents of air? Dig up some of the plants from the soil and search for white cord-like strands attached to the lower end of the stem. In mushroom beds these white cords (" spawn ") are very abundant.

Plants may be obtained during the winter in mushroom houses. They may be grown in cool greenhouses, or in boxes in cellars or basements. (See Mushroom Growing for Amateurs, Bull. 227, Cornell University Agr. Exp. Station, March, 1905.)

There are several other species of *Agaricus* which may be looked for. The horse mushroom (*A. arvensis*) in meadows and pastures. This is a white smooth mushroom, larger than the former plant; the veil is double, the lower portion appearing as radiating patches on the underside. Rodman's mushroom (*A. rodmani*) occurs along streets in cities, and has two rings on the stem. These plants also are edible. Several species occur in woods.

THE INK MUSHROOMS.

These mushrooms are very easily recognized because the gills deliquesce into an inky black fluid. Two large ones are not uncommon on freshly made and manured lawns where they may appear for several years in succession. They occur also by roadsides or in open woods or groves. They appear in May and June, also in September and October, and are both edible.

The ink cap (*Coprinus atramentarius*). This grows usually in dense clusters of five to twenty or more individuals, or sometimes fewer. The caps are gray, oval, and about the size of a hen's egg. Before the gills begin to deliquesce note that the edges are against the stem. Note the thin veil which is left as a thin, angular irregular ring-like narrow projection on the stem where the margin of the cap meets the stem. Split a plant lengthwise and note the broad gills, that they are not attached to the stem. Note how easily the skin peels from the cap. Observe if in some plants there are minute delicate scales on the cap. Note and describe the difference in the surface of the stem above and below the delicate ring. What is the shape of the stem when several plants are in a dense cluster? Does the crowding of the plants make any difference in the shape of the cap? What part of the gills first becomes black? Describe the changes in the cap and gills as the gills deliquesce.

The shaggy main or horse tail (*Coprinus comatus*). These plants are usually somewhat larger than the ink cap, but the cap is cylindrical, white, and very shaggy. Describe the shagginess of the cap, and see if you can determine how it is formed by comparing plants in different stages of growth. Split a plant lengthwise and describe the form and color of the gills, their relation to the stem. Note the hollow of the stem, and the cord inside. How does the ring or annulus differ from that in the ink cap or in the common mushroom? Describe the changes in the plant as the gills deliquesce. Other species of ink mushrooms are often found on manure piles. Some of these may be grown indoors at any season of the year by taking fresh horse manure and keeping it moist in a pan, or in a box for a week or so.

(*To be concluded.*)

A Practical Rule for Tree Planting.—For the best success a time should be chosen when, shortly after planting, the rootgrowth is most active, to supply the demand of the shoots, and when the demand of the latter for water is the smallest and no danger from heaving from frost is present. This philosophy accentuates the well-known rule; in regions with well marked spring and summer rains, spring is the best time; in regions with dry summers and fall rains, fall planting is indicated and that at the beginning of renewed root activity, which will vary, as stated, with species and locality between end of September and middle of

October, and should be ascertained locally. A cool and moist September calls for earlier, a dry and warm for later, planting or even deferring the planting if October also proves dry. Deciduous trees can be planted in fall with more satisfaction than conifers because their root activity lasts longer and the demand for water at the top soon ceases. Fall planting for deciduous trees is said to be even preferable to spring planting when they are severely cut back." (*The Forestry Quarterly,* **2**: 35, Nov., 1903.)

THE BARLEY-CORN.

I. Some Points of Structure.

By Professor Francis E. Lloyd,

Teachers College, Columbia University.

The study of the fruit of the grasses, known as the caryopsis, presents considerable difficulty to the elementary student. Large even as the " grain " of Indian corn may be in some varieties, it is scarcely an easy task to make out the more important structural relations, and one of the commonest errors seen in students' note books is the labelling of the corn grain a " seed." If, however, in our ordinary definition of a seed we exclude the wall of the ovary, it is obvious that this error is due to the failure to distinguish between the seed coats, properly speaking, and their pericarp or ovary wall, which in the grasses closely invests the seed. In the ripened barley-corn the students' difficulty is still greater, since the two paleae or outer and inner chaff also remain attached to the pericarp, to which they are more or less adherent in some varieties. It is for the special purpose of making these relations, in particular, clear that I offer the accompanying illustrations* which, I believe, teachers will find useful in demonstrating the structure of the caryopsis. It should be remembered that a really lucid understanding can be had only by

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* These are made from photomicrographs taken by Mr. Leo Wallerstein from preparations made by myself. I have to thank Dr. Max Wallerstein for the use of the cuts.

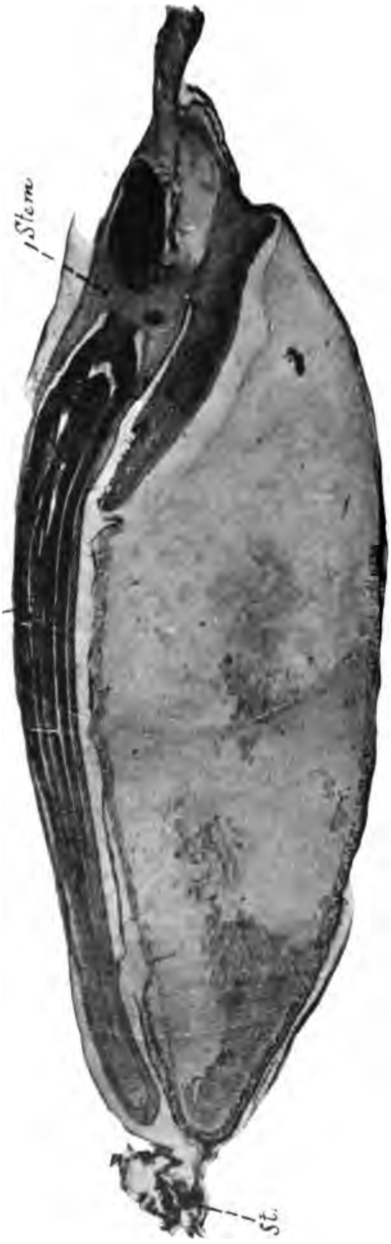

FIG. 40. Longitudinal section through a barley grain after seven days' germination at low temperature. The young embryo extends along the entire length of the grain. The scutellum lies under the right-hand end and against the endosperm, which is light in color. *Stem*, the main embryonic stem; *St.*, the remains of the style.

the study of the development of the barley-corn; otherwise the interpretation of the histology would be very difficult, indeed wellnigh impossible.

The first figure is that of a longitudinal section taken in the middle plane of the barley-corn. On account of the difficulty of cutting the indurated pericarp and paleae, these have been for the greater part removed, although a few fragments remained attached. The general topography of the grain can, however, be seen. By far the greater part of the whole volume is occupied by a mass of tissue, the endosperm, in which are stored up various food materials—starch, oil, proteids—to be used by the sprouting plantlet. In the figure only a little of the endosperm

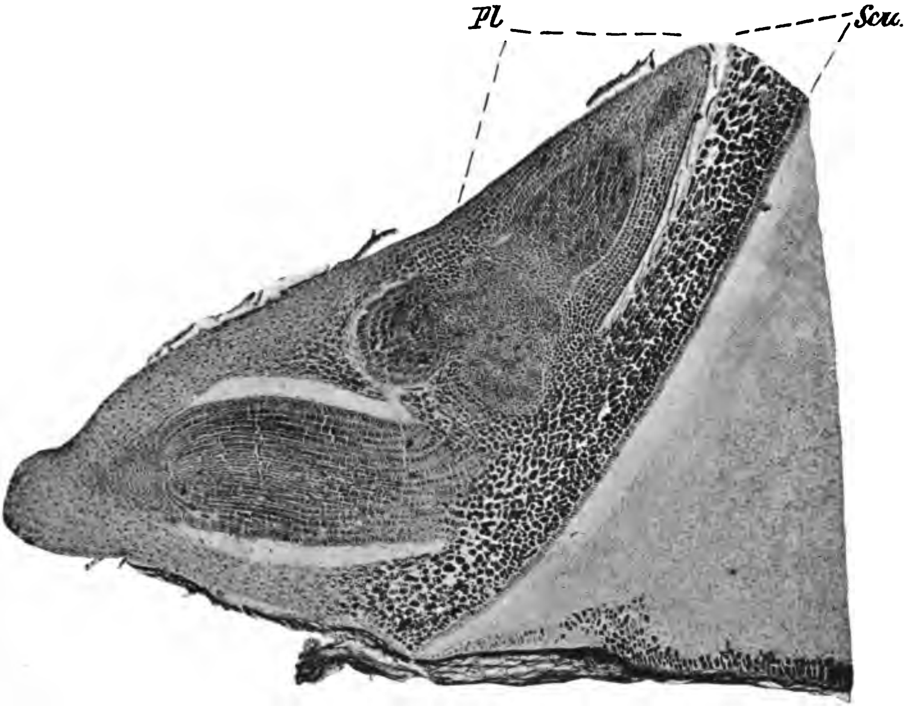

FIG. 41. Longitudinal section through the part of the barley grain which includes the embryo and a small portion of the endosperm. *Pl.*, plumule; *Scu.*, scutellum. The main root, with its root-cap, is seen within the root-sheath. Above it a portion of one of the lateral roots. The right-hand leader from *Scu.* points at the scutellar epithelium.

is actually present for the reason that the embryo has undergone several days' development at a low temperature. As a result, the leafy shoot (plumule) of the embryo extends to the apex of the endosperm, whereas, in the unsprouted kernel, the proportions of the embryo would be as shown in Fig. 41, which includes, however, only the embryo and a small portion of the adjacent endosperm. It will be further noted in Fig. 40, that a rootlet projects beyond the basal end of the grain (at the right-hand extermity); the full length is not shown, as it was four or five times the length of the whole grain. A second rootlet, as yet undeveloped, is seen as a dark conical mass nearby. At the other end of the endosperm the withered and hardened remnants

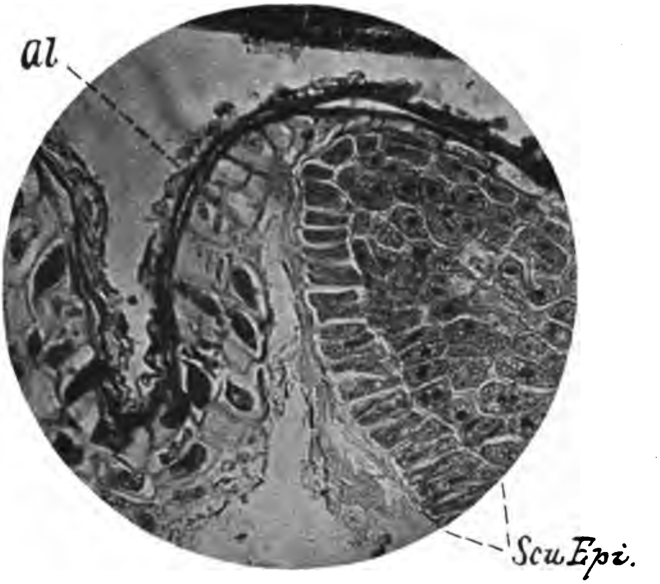

FIG. 42. A portion of upper end of the scutellum, and of the adjacent aleurone layer (*Al.*), under high magnification. *Scu. Epi.*, scutellar epithelium.

of the style are visible (*st.*, Fig. 40). One can trace the tissue of the style down into the pericarp on each side of the endosperm, passing, on the upper side, between the plumule and the endosperm. This position of the pericarp is due to the circumstance that the embryo pushed its plumule through the pericarp upon germination, but instead of growing in a direction determined by its responses to light and gravitation, it is held against the pericarp by the palea, which, however, is not seen in this figure.

Immediately below the pericarp,* which appear merely as a dark line, lies a layer of cells with thick walls. This is the aleurone layer. The cells contain oil and some proteids, and there is evidence that they are important, physiologically, in that they secrete digestive principles which act upon the endosperm. It is not at all evident to a beginner in botany that the embryo lies *within* the endosperm. Indeed this point is scarcely ever thought of, although it is evident enough in many other forms, as, *e. g.*, castor oil. While the position of the embryo is very much on one side, that it lies embedded in the endosperm is clear from Fig. 42, in which may be seen the aleurone layer (*al*) (the outer zone of endosperm cells) passing around the scutellum of the

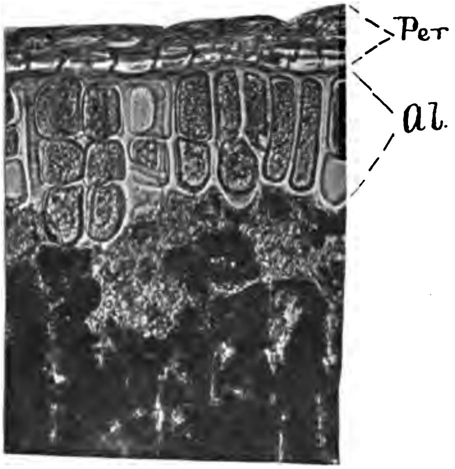

FIG. 43. A portion of the endosperm and the adjacent pericarp (*Per.*) under high magnification. *Al.*, aleurone layer.

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* According to a number of students the layer of cells which I have called the pericarp includes, on its inner face, the seed-coat or testa, recognizable by its brown color (Pammell). I have not been able to satisfy myself of the correctness of this view, and I have therefore, upon comparative grounds, taken the present position.

embryo. Without the aleurone layer, again, lies the pericarp, which is, as one may see, torn and ragged and therefore incomplete. This is due to its adhesions to the chaff, which when torn away took some of the pericarp with it. The whole series of tissues is shown in the next figure (Fig. 44), which is taken from a hand section. It is not very thin, and in consequence does not show the minutiae very distinctly. It does, however show distinctly the chaff (*sp.*), the pericarp (*Per*) and the aleurone layer (*al*), with the starchy endosperm, of course, within. It is thus clear that, if the origin of the pericarp has been correctly traced, the barley-corn is a caryopsis, *i. e.*, a seed (= endosperm and embryo) enclosed by a tightly investing ovary wall or pericarp, the whole covered by the two chaffy paleae or "spelt," as they are called by the brewers.*

The remainder of the endosperm is composed of cells, less regular in form than those of the aleurone layer, which, with the exception of some of the outer ones, immediately beneath the aleurone layer, from which starch is absent, are all packed with starch. These may be seen in Fig. 43, in which the cells with very dark contents (starch stained with iodine) are seen not to come quite up to the regular, thick-walled aleurone cells. The lighter irregular portion thus distinguished is composed of the cells referred to, which do not contain starch.

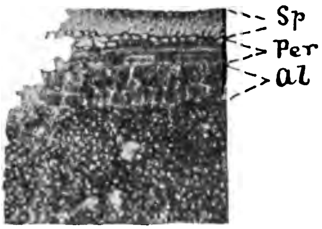

FIG. 44. A portion of transverse section through the chaff (*Sp.*), pericarp (*Per.*) and endosperm. *Al.*, the aleurone layer, under which is the starch-containing tissue.

Returning to Figs. 40 and 41 we note that the embryo lies against the endosperm. The part which touches the endosperm is the scutellum (*Scu*, Fig. 41), an organ which secretes digestive principles and absorbs the food materials from the endosperm after they have been digested, and thus prepared for the use of the sprouting plantlet. The part especially active in secretion is the epithelium, a layer of columnar cells (*scu. epi.*, Fig. 42. It may be traced also in Figs. 41 and 42.) Fig. 42 shows also very nicely some of the remnants of the disintegrated endosperm. This

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* From the German *Spelze.*

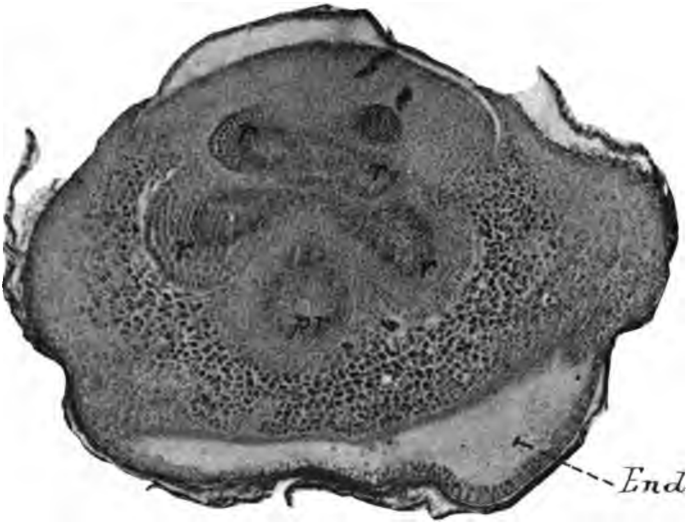

FIG. 45. Transverse section through the rootlets, the tissue below, which is the scutellum. *End.*, endosperm.

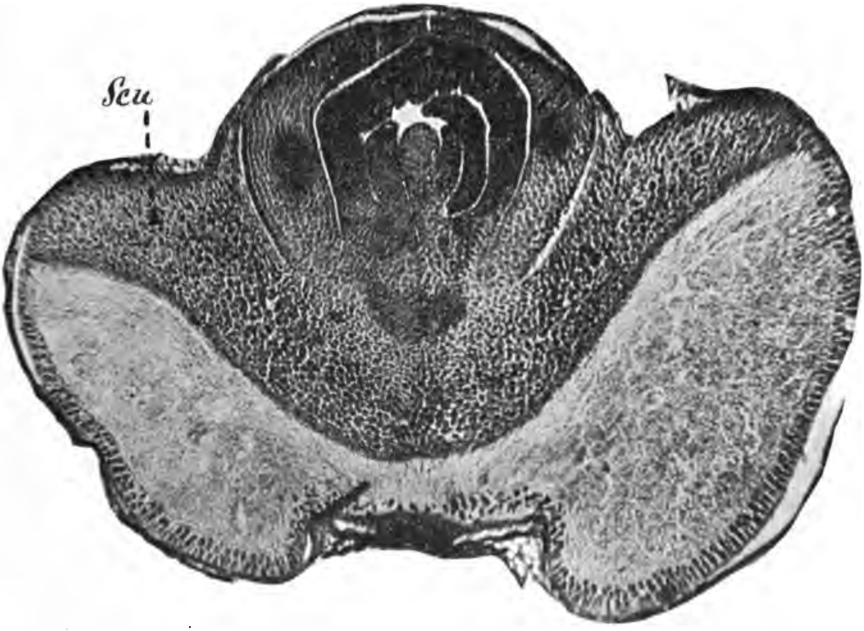

FIG. 46. A similar section through the base of the plumule. *Scu.*, scutellum.

photograph was made from the same section as Fig. 40, but embraces only a small portion of the upper, left-hand end of the scutellum.

In Fig. 41 the parts of the embryo may be seen in detail. *Pl* is the plumule, a short axis or stem on which are borne the young leaves. Our figure shows two of these. The other end of the embryo is composed of a root sheath surrounding the embryonic roots, of which there are several. One of these is median, and appears in this figure cut longitudinally. Its histological structure and that of its root cap are clearly seen. The disposition of the lateral roots (*r*) is best seen in a transverse section passing through the base of the median root *Pr.,* (Fig. 45). The asymmetry of this section is apparent, and not real, and is due to the fact that the cut is not exactly transverse. In the possession of

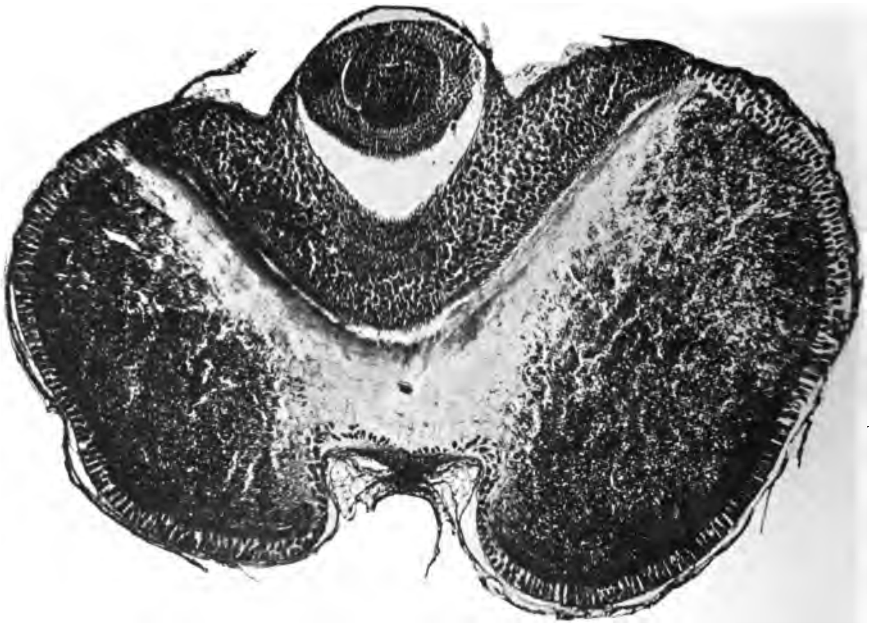

FIG. 47. Transverse section of a grain through the tip of the plumule. The groove which runs along the inner side of the grain is seen as a notch, which is partly filled with loose tissues derived from the nucellus, testa and pericarp. The groove is traversed by a strand of vascular tissue.

several roots already well started the barley embryo differs from that of most other grasses.

Fig. 46 is taken from a transverse section passing through the base of the plumule, and here can be seen the whole series of leaf fundaments. *Scu.* is the scutellum, or supposed cotyledon. The section shown in Fig. 47 is taken through the tip of the plumule, and shows well the vascular tissue (in the notch below) which arises along the line where the edges of the carpel fuse. Fig. 48 is taken from a section passing through the body of the grain. At the upper left and lower right hand may be seen very well the irregular layer of cells which underly the aleurone layer. The cells containing starch, composing the remaining interior mass, appear light, the black points being the

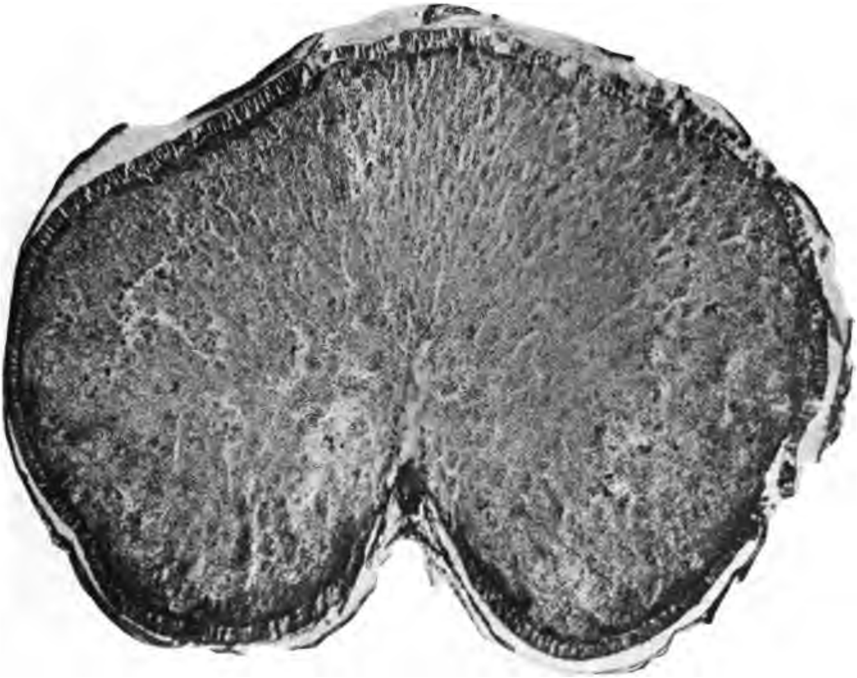

FIG. 48. Transverse section through the middle of the grain beyond the embryo. The irregular darker zone of cells which underlies the aleurone cells does not contain starch. The rest of the endosperm is crowded with this food material.

hollow centers of the starch grains. The light color of the starch is due to the transparency of the grains brought about by the medium of preservation.

It is my purpose at a later date to discuss some features of the physiology of the germinating barley-corn.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

Are Potato Tubers Caused by a Fungus?—Various experiments have been carried on for the purpose of determining the conditions for the profitable cultivation of *Solanum commersoni,* a close relation to our common potato, a native of the eastern portions of South America. The great practical interest of this plant lies in the fact that it grows in marshy soil that is unsuited to other crops; but so far its successful cultivation with edible tubers has been limited to the grounds of Labergerie, near Vienna. It has been supposed that this species is the progenitor of the cultivated potato, but nothing definite has been determined on this point.

In *S. commersoni* the tubers are small, and are formed very slowly at the ends of long stolons. From results incidental to some extended researches into the relation of endotropic fungi to the formation of tubers in various plants Noel Bernard* infers that these qualities were characteristic of the *S. tuberosum,* when that plant was first introduced into Europe; and that it was only after the soil had become generally infected by the endotropic fungus peculiar to the potato that tuberization became earlier as well as more regular and abundant.

It occurred to M. Jumelle:† Is it not possible, by infecting artificially at the time the tubers are planted, to reach at a single stroke the point it had taken so long to reach in the case of *S.*

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* Bernard, Noel. Etudes sur la tuberisation. Revue General de Botanique, 14: 5, 58, 101, 170, 139, 269. 38 figs. 3 pls. 1902.

† Jumelle, Henri. De l'influence des Endophytes sur la tuberisation des *Solanum.* Rev. Gen. de Bot., 17: 49. Feb., 1905.

tuberosum? To this end he made parallel cultures of two varieties of the common potato (Early Marjolin, and Lyon Giant) and of the *S. commersoni.* He first obtained a quantity of the mycelium of the endophyte by sterilizing the surfaces of slices of tubers of the Giant variety, and allowing the hyphae to develop until spores were formed. From these spores, which proved to be of a species of *Fusarium,* agreeing with the experiences of Bernard, he grew mycelium on other slices of sterilized potato. Certain tubers of each kind experimented with were infected with some of this mycelium at the time of planting, while others were left as they were. The soil was the same for all, as well as the time of planting and of digging up the tubers.

The same numbers of infected and of non-infected tubers were planted in each case, and the weights recorded. From time to time single plants with all their underground connections were dug up, the tubers counted and weighed, the stolons counted and measured, and the weights of the aerial portions noted.

In the case of the Early Marjolin (the same variety as that with which Bernard had experimented) the yield of tubers compared to the weight of "seed-potato" was about twice as great with the infected plants as with the non-infected; while in the case of the other variety there was no notable difference either way. The artificial infection in the case of *S. commersoni* produced no constant results. With some individuals the tuberization seemed to be increased, while with others the reverse was true. In general, there seemed to be an increase in the number of stolons, but this influence did not continue through the season.

It had been intended to use the mycelium of the fungus proper to this species of *Solanum,* but the author did not succeed in getting sufficient by artificial cultures. The tentative conclusions are that while infection does seem at first to produce an influence upon tuberization such as was pointed out by Bernard, this influence is nevertheless not sufficiently great nor definite to involve absolute certainty without further investigation.

According to the theory of M. I. Gallaud* the unsatisfactory results of these experiments are due to the fact that the mycelia obtained by the methods of Bernard and of Jumelle are not the endophytes that really influence tuberization, but accessory forms. Still, Jumelle is certain that a species of *Fusarium* does have some influence and it is his intention to continue his researches in the hope of obtaining some positive results.

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* Gallaud, I. Etudes sur les Mycorhyzes Endotrophes. Rev. Gen. de Bot., **17**: 5. 1905.

C. S. G.

OUTLINE OF A COURSE IN PLANT CULTURE.*

By Asa S. Kinney, M.S.,

Mt. Holyoke College.

Section I. Early stages of growth of the plant.
- A. The seed.
    1. Structure.
    2. Absorption of moisture.
    3. Testing vitality.
    4. Moisture necessary for germination.
    5. Air (oxygen) necessary for germination.
    6. Heat necessary for germination.
    7. Soaking in water before planting.
    8. Why cover when planted.
    9. Use of cotyledons.
    10. Best soil for germination of seeds.
    11. Subsequent care after planting.
    12. Causes of failure to germinate.
    13. Cracking seed coat before planting.
    14. Time required for germination.
    15. Depth of planting.
- B. The plantlet.
    1. Development of caulicle.
    2. Formation of primary and secondary roots.
    3. Root hairs (rhizoids).
    4. Development of plumule (hypocotyl, epicotyl).

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* Given at Mt. Holyoke College, and requires two hours per week lecture, four hours in the laboratory for the spring semester.

5. Special processes for removing seed-coat.
6. Treatment of seedlings in culture, watering, transplanting.

SECTION II. Ascending portion of plant.

A. The stem.

1. Function.
2. Structure and Devlopment
    - Dicotyledonous (wood, bark, pith).
    - Monocotyledonous (fibro-vascular bundles, parenchyma).
3. Fibro-vascular bundle, (wood, bast).
4. Cambium layer.
5. Annual rings.
6. Function of xylem and phloem.

a. Propagation by stem.

1. Cuttings (herbaceous, woody).
2. Place and media for rooting cuttings.
3. Growing cuttings in living room.
4. Grafting: splice, tongue, saddle, side-crown, triangular-crown, veneer, cleft, bottle.
5. Reasons for grafting.
6. Principles governing the process.
7. Time, material for scions, condition of stock, grafting-wax.

b. Treatment of stem.

1. Pruning (time, methods, reasons).
2. Protection of stem in transplanting.
3. Healing and protection of injured stems.
4. Cause of flow of sap when trees are tapped in spring.

B. The leaf.

1. Structure (tissues, stomata).
2. Function (photosynthesis, transpiration).
3. Chlorophyll (properties, function).
4. Conductive portion.
5. Development (relation to light).
6. Propagation by (Begonia).

C. The bud.
  1. Structure (protective coverings).
  2. Arrangement on stem (flower, leaf).
  3. Function.
  4. Propagation by (shield and T budding).
  5. Disbudding to increase size of flowers.

D. The flower.
  1. Structure.
  2. Function.
  3. Cross-fertilization and hybridizing.
  4. Selection for seed purposes.
  5. Changing color and shape by selection.
  6. The increase of size, number and quality in cultivation.

SECTION III. Descending portion of plant.

A. The root.
  1. Function (absorption of nutriment to anchor plant).
  2. Structure.
  3. Region of growth (root-cap).
  4. Absorptive region (root-hairs).
  5. Conductive portion.
  6. Relation of root to oxygen.
  7. Absorption of liquids (osmosis).
  8. Passage of liquids; root pressure.
  9. Use for propagation (cuttings, grafting).
  10. Care of roots in culture.

B. Soils.
  a. Mechanically considered.
    1. Early formation; cooling, decomposition, glaciers, organic matter, life, disintegration of rock.
    2. Structure (analysis).
    3. Use of soils.
      (*a*) Reservoir for storing water.
      (*b*) Laboratory in which changes are taking place.
    4. As water retaining medium.

- (*a*) Capillary attraction.
- (*b*) Percolation of water.
- (*c*) Specific gravity.

5. Classification; light, warm, sandy, heavy, cold clay, loamy, humus.

b. Chemically considered.

1. Chemical composition.
2. Chemical elements necessary for plant growth: Oxygen, Hydrogen, Nitrogen, Carbon, Sulphur, Phosphorus, Potassium, Magnesium, Iron, Calcium and Chlorine.
3. Subsidiary substances: Sodium, Silicon.
4. Admixtures, Zinc, Copper, Nickel, Aluminum, Cobalt, Manganese, Lithium, Strontium, Barium, etc.
5. Use of the different elements in the growth of plants.
6. Water and Quartz sand cultures.
7. Absorption of free Nitrogen by Leguminosae.
8. Chemical substances that it is necessary to supply to the soil: Potash, Nitrogen, Phosphorus.
9. Sources of supply.
   - Commercial fertilizers
     - Potash
       - Sulphate
       - Muriate
     - Nitrogen
       - Nitrate of Soda
       - Sulphate of Ammonia
     - Phosphorus
       - South Carolina Rock
       - Thomas Slag
       - Bone Meal
       - Bone Black
   - Organic
     - Green Manuring
     - Stable Manures
   - Supplied by rain.
10. Pot culture (liquid manuring).
11. Humus.
12. Mycorrhiza (trees).

- *b.* Repotting.
  - 1. When and how done.
  - 2. Preparation of soil and subsequent care of plants.
- *c.* Destruction of insects and fungi.
  - 1. Insecticides.
  - 2. Fungicides.
- *d.* Naming more common species; their characteristics and habits.

B. Care of plants in the open ground.

- *a.* The early preparation.
  - 1. Time and place to purchase seeds.
  - 2. Preparation of soil, time and method.
  - 3. Laying out and planning for different crops.
  - 4. Material used: Radishes, Lettuce, Pansy, Verbena, Petunia, Coleus, Geranium.
- *b.* A " School Garden."
  - 1. How to lay out the garden and arrange to supply the requirements of the children.
  - 2. Points to be emphasized and best methods to hold the children's interest.

SECTION IV. The plant.

A. Care of plants in the green-house.

- *a.* Watering.
  - 1. Amount of water required, determined by kind of plant and intensity of vital processes.
  - 2. Results of over-watering.
  - 3. Resting season of plants, water required.
  - 4. Growing season, water required.

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THE DEFENCES OF THE COCK-SPUR THORN.

By R. G. Leavitt, Ph.D.,
The Ames Botanical Laboratory.

The long, slender spurs of *Crataegus Crus-galli* are very sharp to the hand, but—if you wish to try their defensive quality best—still sharper to the tongue. They are stems, springing from the axils of leaves. They bear no leaves except weak vestiges at an early period. These soon fall away leaving the tapering axes naked, smooth, and sharp. Trees of this species grow near our laboratory and while passing them recently I was struck by what appeared to be a marked downward tendency of the thorns. It seemed to me that the large majority were directed to points below the horizon. Yet, since their position is primarily determined by that of the subtending leaves, and since these leaves are arranged spirally upon the branches, there was a probability that the thorns would on fuller examination be found to be spirally distributed also and directed towards all quarters of the environment impartially. Between eye and logic only statistics could decide. Accordingly I counted the total number of thorns on several outstretched branches, and then the number that pointed below the horizontal plane. This procedure demonstrated immediately the great preponderance of downward-pointing thorns. I discovered that many, in fact most, of the thorns were curved downward; so that even if originally directed upward at an angle of, say, 35° above the horizon, they had turned from this elevation so as to point out horizontally or even subhorizontally. Those that had sprung from the under side of the parent branch and were originally directed obliquely downward were at maturity generally still further declined. Usually the deviation from the original angle was notable at the very base of the thorns, so that they sat obliquely upon the supporting limb. Those alone which happened to be seated upon or near the upper or under median line of the limb showed no signs of obedience to the usual law, but grew straight up or straight down. The numbers borne upon the upper and under faces of the limb were very nearly equal; the prevailing declination, therefore, was something not predetermined by position but induced during the development of the thorns. The count, as to the proportion of spurs affected by the observed tendency, gave the following returns. "Subhorizontal" here includes all those with points ultimately directed below the horizontal plane. Whole number, 172; subhorizontal, 119; somewhat declined, 38; unaffected, 15. A further exact accounting was not necessary since a survey, in the gross, of several trees confirmed the plain purport of this table, namely, that the spurs of *Crataegus Crus-galli* are influenced by some power guiding their growth so that, when mature, most of them bristle toward the earth.

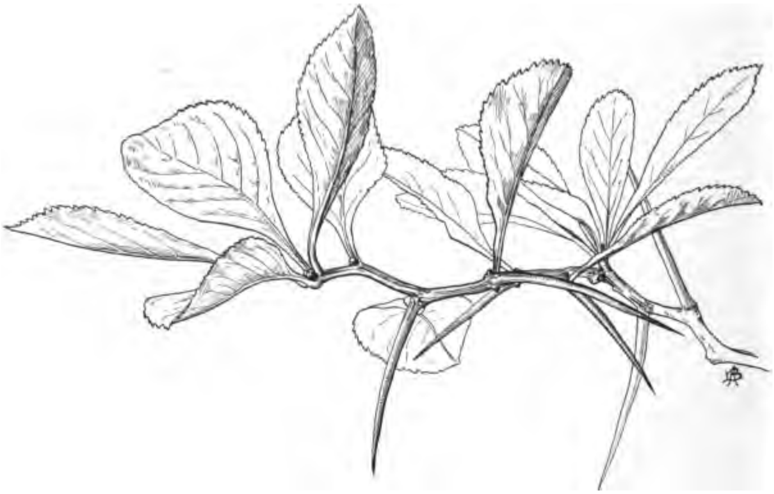

FIG. 49. Twig of *Cartaegus Crus-galli,* Cock-spur Thorn.

This is a noteworthy fact. Down-growing shoots are not common. Most shoots ascend: either their tendency is to grow straight up, away from the earth and toward the light, or, in the case of the branch-shoots they tend obliquely upward. Not a few constitutionally grow out level. But very few shoots, in normal plants, turn their apices earthward. None of the shoots of *Crataegus* do so except the thorns; and it is very singular and interesting to find that these branches, so highly modified in form by reduction of leafage, limitation as to growth in length, hardening of the bark and wood, and sharpening of the apex, also differ from all the other branches of the tree in their physiology.

For their attitude is a physiological rather than structural matter. Shoots and roots of plants do not ordinarily grow in self-determined directions. Gravity, light, moisture, as stimuli, guide the axes in their elongation. The root avoids the light, turns toward a moist environment, and by a kind of sense of the direction of gravity, finds its proper general course through the soil. The shoot is gifted with a responsiveness to, or sense of, the lines of gravity and of light. These thorns turn downward, we may be sure, because while still plastic and growing they are moulded by the influence of external forces.

Such an anomaly in stem-growth calls for a biological "reason." Our philosophy seems always to demand proper utilities for unusual arrangement and deportment in normal plant life. What, then, is the usefulness to the tree of the strong downward bent of these spurs? The answer is doubtless to be found in the browsing habits of certain foes of *Crataegus*. The thorns are evident defences against those animals which in a wild state feed, or formerly fed, upon the leaves,—pricking their noses, lips and tongues. But why should *down-pointing* thorns be better than others?

The Herbivorae whose depredations were of old the "reason" for the existence of the thorns in *Crataegus* and allied plants were members of the Bovidae and Cervidae—the ox and the deer tribes. We may, therefore, perhaps get the information we want by applying to the domestic cow. If we watch her as she feeds, we at once see how important a part the tongue plays in securing food. While the horse seizes his food with his lips, the cow, on the other hand, constantly makes use of the tongue in grazing. It shoots out from right or left and with a quick, sweeping, circular motion draws the grass in. If a handfull of clover is held toward a hungry cow she will reach for it with extended tongue, which, if necessary, may be protruded several inches beyond the muzzle. The tip curves around the desired food and the rough surface helps to hold it. From constant use the tongue becomes a strong and adept organ of prehension.

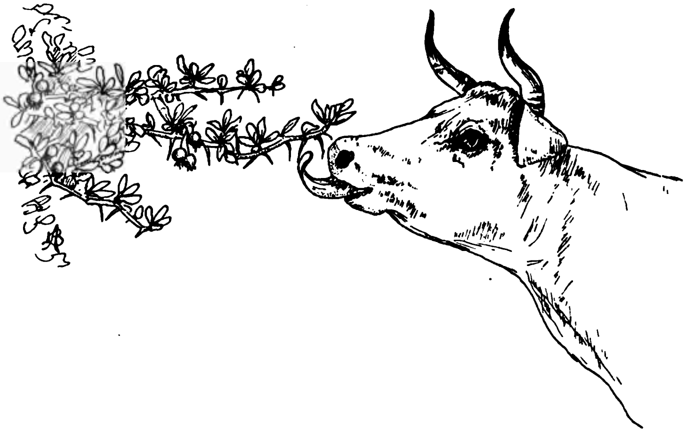

FIG. 50. The way in which Cock-spur Thorn is protected against browsing cattle.

Now note that in browsing, when such an object as the depending branch of a tree is sought, the protruded tongue curves upward, and the branch is seized from beneath, as shown in our illustration (fig. 50). This is the habit of the deer, as well as of the ox, kind; and this observation makes it plain that the tendency of the spurs is a nice adaptation to their munitive function, with a view to the foes to be feared and the quarter from which attack is to be expected. It is not unreasonable to surmise that had the browsing animals of northern temperate regions—the home of *Crataegus*—been of the horse kind, then the spurs of our plant would have pointed at all angles indifferently.

As to the precise stimulus to which the general declination of the thorns is due, it is not easy to decide between gravity and light; that is to say, whether the thorns are, in the phrases of the physiologist, positively geotropic or negatively heliotropic. Only by an exact experimental method would it be possible to determine the nature of the influence. I think, however, that light is the chief, if not the sole, agent. I have been able to observe the results of several experiments arranged, as it were, by Nature. I note that the thorns on the under side of the limbs are sometimes turned away from the vertical. When this occurs it is often apparently explained by the light relation. And in a few cases I found that thorns which had been densely shaded under very near foliage of a neighboring tree had actually turned strongly toward the shade, when gravitative influence would have produced an opposite effect. The thorns therefore seem to turn away from light; that is, to be negatively heliotropic.

A point in the evolution, or supposed evolution, of the thorns has interested me, and I venture to introduce it here. Notwithstanding some recent advances of moment the modes of evolution are still very obscure. In spite of uncertainties, however, there is a mental satisfaction in finding any signs of the course which a particular evolutionary development has followed. Accordingly I examined, for suggestions, the numerous species of *Crataegus* and the near relatives of *Crataegus* in the great living collections at the Arnold Arboretum, especially the pears (*Pyrus*), apple (*Malus*), and the quince-like *Cotoneasters.* From them it is possible to argue a plausible history for the splendidly finished spurs of *Cartaegus Crus-galli* and other species of the genus. It is to be observed that in this group a differentiation of two kinds of stems is common. There are the ordinary running stems of indefinite growth, and upon them short side stems. The latter together bear most of the foliage; the internodes are very short and compressed, and the elongation is strictly limited. They are hard and rigid, and late in the season—at least in some species—are capped by small hard pointed buds, so as to be decidedly sharp in the hand-grasp. They are common in *Pyrus* and *Malus.* Then in some species there are two kinds of limited lateral stems, one like those just described, ending each year of active growth in a leaf-bud, another of one or two year's growth at the utmost, bearing several leaves of the usual kind and ending in a hard pointed thorn-like extremity beyond them. This is the case, *e. g.*, in *Pyrus malifolia, P. communis,* and *Crataegus oxyacantha.* Again in *Cotoneaster Pyracantha* the acute side branch has functional foliage leaves, but they are much reduced in size, and the case approaches that of *Crataegus Crus-galli.* Finally, in the latter, the last essential step is taken; the leaves become non-functional, while the hardening and sharpening and in addition the heliotropic declination give the completed weapon of defence.

The first definitely defensive modification probably affected only a small region of the extremity of the lateral branchlet, perhaps as a hardening of the axis of the winter bud. Reduction of the leafage may have been the incidental result of a further increase of purely mechanical tissue and consequent decrease of conducting elements of the wood, as the hardening extended to the whole axis. But antecedent to every distinctively defensive modification was the critical first step—restriction of longitudinal growth. It is the most interesting aspect of this history—which, we must keep in mind, is plausible but not proven —that this step had relation not to the ultimate munitive function but to another use—leaf bearing. This is evolution by indirection; and it is characteristic of organic evolution that while, structurally considered, an organ may march straight from an initial to a final condition, the successive functions which make the several steps of this progress intelligible may form a circuitous and unrelated series. This principle is to be borne in mind when the objection is raised against the theory of natural selection with gradual transformation, the objection that unfinished organs being useless the imperfect stages will not be preserved by selection and that therefore the evolution of these organs can not be attributed to any part played by them in the survival of the fittest; in short that evolving structures can not pay their way to the destination as, according to the theory, they should. But whether incipient transformations in any given case have been immediately and intrinsically useful can only be judged when the history of functions as well as of structures is known.

OUTLINES FOR THE OBSERVATION OF SOME OF THE MORE COMMON FUNGI.

By Professor George F. Atkinson,
Cornell University.

(*Conclusion.*)

Poisonous Amanitas.

The genus *Amanita* contains some of the most deadly mushrooms (or toadstools as some call them, though in reality there is no difference between a toadstool and a mushroom). The amanitas have white spores (as can be seen from a spore print on paper); the gills are usually free from the stem, or the stem separates easily from the cap; there is a veil and ring as in the common mushroom, and there is, in addition, a distinct outer veil or envelope which surrounds the entire plant. In some this envelope is in the form of a bag which splits at the top and allows the pileus and stem to emerge, leaving the bag on the base of the stem. In others, the upper half of the envelope remains clinging to the pileus and is torn into large warts or patches which are scattered on the expanded pileus, while the lower half of the envelope remains at the lower end of the stem in the form of scales or scaly rings, or a plain ring, according to the species.

The "destroying angel" (*Amanita verna*).—This is a pure white plant of a beautiful white color, and because of the very deadly poison which it contains is sometimes called the "destroying angel." It occurs from June to September, usually in woods, but sometimes in lawns. In the young stage it is sometimes mistaken for the common edible mushroom, and with fatal results. Great care should be exercised by the beginner in noting characters of stem, ring, enveloping bag, and color of gills, so that suspicious plants may be avoided. It is best at first to dig up all plants to be certain to get all the parts of the plant which may be in the ground. In this amanita the stem is usually deeply inserted in the ground. If possible, find this plant in different stages and note and describe the form at different stages, the depth of the stem in the ground, how the plant emerges from the envelope, the character of the pileus (smooth and viscid to the touch, etc.), gills, stem, ring, and bag or *volva.*

The fly amanita, sometimes called false orange (*Amanita muscaria*).—This also occurs in woods and groves. It too is deadly poisonous but the poison can be counteracted if a physician is called in time, by hypodermic injections of atropin. In this plant the outer envelope or volva does not form a bag, but the upper part forms numerous white scales on the orange, or reddish orange cap, while the lower half forms two or three coarse scaly rings on the base of the stem. Note the form and distribution of the scales on the pileus, the color of the pileus, the striations on the margin, and the character of the surface to the touch. (These mushrooms are not poisonous to the touch, it is only when eaten that they are poisonous.) Note color of gills, character of the stem, and of the veil and ring. How do the veil and ring on the stem differ in appearance and origin from the coarse scaly rings on the base of the stem?

EDIBLE AMANITAS.

Although there are a few species of *Amanita* which are edible, it is better for beginners to avoid eating any of them. There are, however, strong reasons why they should be carefully studied.

The royal amanita, or royal agaric (*Amanita caesarea*).—This is one of the most beautiful of all the mushrooms. It occurs in July and August, in woods or open woods or groves. The cap is a rich orange, striate on the margin; the gills are yellow, and the veil is usually yellow, while the volva is white, thick, and bag-like. The plant is more common in the Southern States than in the north. Compare these plants with the two former amanitas, describe the points of difference and resemblance.

The reddish amanita (*Amanita rubescens*).—This is about the size of the fly amanita, but the pileus is suffused with red, the envelope is thinner and more delicate, and is all more or less crumbly and easily washed off by rains. Compare it carefully with the fly agaric.

Beginners should avoid eating amanitas or any suspicious fungi. It is better at first to submit the mushrooms to some one who knows them.

Lepiotas.

The lepiotas are closely related to the amanitas but lack the envelope or volva. The spores are white, the gills are mostly free from the stem, which in the true lepiotas separates easily from the pileus. A veil and ring are present. The two following species are edible.

The smooth lepiota (*Lepiota naucina*).—This is entirely white, or sometimes the cap is very pale gray. It occurs in lawns, pastures and even in cultivated fields, in late summer and autumn. Note the form of the plant in different stages of growth, the shape of the pileus, of the gills and their relation to the stem, character of the veil on the young plant and in the old plant. Note that as the plant dries the gills become brownish. What genus does it then resemble?

The parasol mushroom (*Lepiota procera*).—This occurs in pastures and open woods or groves. Compare it with the smooth lepiota, and describe form, surface and color of the cap, character of the gills, stem, and ring. Is the ring movable on the stem?

Other Agarics.

There are a great many other agarics not only in the genera described above but in other genera. It will be interesting for the pupil to compare those found with the ones described above, and the teacher can if possible supply the names. One should always note the *habitat, i. e.,* where the plant grows, and whether on the ground or on leaves, humus, twigs, logs, stumps, standing dead trees or from wounds of living trees. Interesting ones to study are the "milk" bearing agarics of the genus *Lactarius* which bleed a white or colored juice when the *gills or cap* is cut or broken.

The delicious lactarius (*Lactarius deliciosus*) has an orange juice and is edible; the peppery lactarius (*Lactarius piperatus*) and many others have a white and peppery or acrid juice, the indigo lactarius (*Lactarius indigo*) has an indigo blue juice, while some others have a juice which is at first white but turns yellow, or violet, etc., on exposure to the air.

The chanterelle (*Cantharellus cibarius*) is a yellow plant with narrow, blunt, forked gills, which occurs in woods.

The honey agaric (*Armillaria mellea*) is a very common agaric growing usually in dense clusters from dead roots or about stumps in the latter part of August and in September and October. The cap is often honey colored, there is a thick white veil, and the stems are pale grayish brown, the gills are attached to the stem and the spores are white. This is such a common one it might be used for study in the fall. Careful observations can be made of all parts of the plants, and one should search in the soil where the stems are attached to the roots, etc., for black cords to which the stems are attached and which grow over the surface of the dead roots, sometimes also growing underneath the bark of living roots and killing them.

In July and August the "Jack my Lantern" mushroom is often found (*Clitocybe illudens*). It is large, grows in dense clusters, is yellowish, the gills growing down on the stem, and it is beautifully phosphorescent at night.

Polyporus and Bracket Fungi.

These are plants in which the fruiting surface (that which bears the spores) is in the form of a honeycomb on the underside of the cap. Some of the bracket fungi are gill bearers, but the most of them are polypores (polyporaceae) or tube fungi. Some polypores, however, grow on the ground, have a circular cap and a central stem. A large number of these, especially those which are fleshy and soon putrefy belong to the genus *Boletus*.

The edible boletus (*Boletus edulis*).—This is a very large plant occurring in woods or groves in July, August and September. If this cannot be found, almost any one of the genus will answer for the study. Note size and shape of the plant and its parts, the color of the different parts and markings of the surface; note the form and relation of the pores forming the honeycombed under surface. See if the layer of tubes will separate from the flesh of the cap by trying to pull or twist it off. Note if the color of the plant, as that of the tubes or flesh of pileus or stem, change in color where bruised or cut. Some change to blue, red, etc. Some boleti are said to be poisonous.

The bracket fungi with woody texture.—These are polypores which usually live from year to year; they grow on wood (trees, stumps, etc.) and sometimes attain a great age, from twenty to eighty years. They are called bracket fungi because the cap is attached to the side of a tree or log like a shelf. The honeycombed surface is underneath. Each year a new layer of the tubes or honeycomb surface is laid on underneath by growth, and to the margin of the pileus is added a ring or new margin so that usually the bracket becomes thicker and broader each year. Select some of the larger ones for study. Note shape, attachment to the tree, color, surface markings, as well as the size and color of the tubes. Count the number of rings or concentric ridges on the upper surface of the pileus. Split the plant in two through the thickest part and parallel with the tubes. Count the distinct layers of tubes. One layer of tubes is added each year. How old is the plant and how do the number of layers of tubes compare with the number of concentric rings on the pileus?

FAIRY CLUBS AND CORAL FUNGI.

These mostly belong to the genus *Clavaria* (a club). Many of the plants are club-shaped and vary from half an inch or so up to four to six inches. They grow on rotting wood and leaves, but chiefly on the ground. Many of them are simple, that is, not branched, while others are very profusely branched from a common short stem. These much branched forms are sometimes called coral fungi because of their resemblance to coral. Search for different kinds. Describe the shape, color, character of branching, texture, color of the flesh, and determine the color of the spores by laying some plants on white paper over night. None of the fairy clubs or coral fungi are known to be poisonous.

HEDGEHOG FUNGI.

These plants are called hedgehog fungi because of the large number of awl-, or spine-like processes, which hang down on the underside of the cap or of the branches of the plant. The spores are borne on the surface of these spines. Many of these fungi are placed in the genus Hydnum. The four described here are edible.

The coral hydnum (*Hydnum coralloides*).—This grows on dead wood, is entirely white, and forms a tuft of branches three to four or more inches wide. The branches are slender and the spines rather delicate.

The bear's head (*Hydnum caput-ursi*).—This is similar to the coral hydnum but is coarser and the spines are stouter and longer.

The hedgehog (*Hydnum erinaceus*).—This is like a large white knot on the side of a tree, with stout and long white awl-shaped spines on the underside, one to two inches long. Place a portion of the plant on paper over night to see the color of the spores. Describe, illustrate, and compare the different species which are found.

The repand or uneven hydnum (*Hydnum repandum*).—This grows in woods on the ground and has a stem and pileus something like an agaric, but the spines are on the underside of the cap instead of gills. The plant is 4-6 inches high, and the cap 2-4 inches broad. It is whitish or pale tan. Note the form of the cap and how the form varies in different specimens. Is the plant fragile or tough? What is the color of the spores?

TWO EARLY CUP FUNGI.

The cup fungi are so called because the plants are in the form of a cup, saucer, or beaker. There are two very early species which appear in the latitude of central and southern New York from the last of March to the last of April. They are as follows:

The scarlet cup (*Sarcoscypha coccinea*).—This grows on decaying sticks, branches, etc., on the ground. The plant is deep cup-shaped and an inch to nearly two inches in diameter. The outer surface is pure white and somewhat hairy. The inner surface is bright scarlet. The plant is found in woods or groves in damp places, often in ravines.

Note the form of the plant, and if young ones are found note that they are at first enclosed like a small hollow ball, but later open at the upper side to form the cup as they enlarge. Note that the plant is attached by a small portion of the under surface to the decaying stick. Sometimes as the plants are drying slightly, or as they are handled, a puff of white " smoke " rises from the inside of the cup. Watch for this. The inside of the cup is the " fruiting " surface and the " smoke " is made up of myriads of minute microscopic bodies called " spores," which function as seeds in propagating the plant, though they are not true seeds.

The black urn or goblet (*Urnula craterium*).—This also grows on dead decaying sticks, etc. In shape it is very much like a small beaker or wine glass and is very black both inside and outside, or when young and fresh sometimes with a pale brownish or fawn color. The mature plant is two to three inches high, the stem is slender and about half this length, while the " cup " is oval to urn-shaped, and from one to one and one-half inches in diameter. The plant often grows in dense clusters, or in a row on a slender stick in damp woods.

Note the form and attachment of the plant. Search for young or half grown specimens. Note that the " cup " part when young is closed at the top. Specimens half grown can be kept in a moist chamber in the laboratory. When found they should be kept in this way under observation. As they open note that the margin of the cup becomes split into regular and prominent teeth which recurve as the cup expands and make very pretty objects of the plants. Note the change in form, in the character of the outer surface, etc., as the plants become older. Watch for the " clouds " of spores.

THE MORELS.

The morels are also early fungi. They appear in May, and grow in damp situations in open woods or in damp low fields or waste places. There are several different species which are rather closely related and are not uncommon. The plants are conspicuous in size, and upright and elongated. In the common forms the plants are three to six inches high and one to nearly two inches in diameter. The stem is about one-half the length of the plant, sometimes less, sometimes more, and is usually a little less in diameter than the "cap." The cap or head is oval to cylindrical or conic and is marked by deep and large depressions giving an irregular coarse honeycombed appearance to the surface.

Note the form of the plant and proportions of stem and "cap." Note the character of the surface of the stem. Note the form of the pits or depressions over the cap, and their arrangement in different specimens. Split a plant lengthwise and note the characters. *Morchella esculenta* and *M. conica* are two common species. The morels are edible.

THE HELVELLAS.

The helvellas grow in similar situations as the morels. The plants are erect, have a distinct stem, while the cap is mitrate and is formed of a more or less irregular thick plate-like structure surrounding the upper part of the stem and coarsely wrinkled or convoluted or is somewhat saddle-shaped.

Gyromitra esculenta (the esculent convoluted cap) occurs about the same season as the morels, and is of quite good size, two to three or four inches high and nearly as broad. The cap is strongly wrinkled or convoluted and dark brown. The stem is stout, being an inch to nearly two inches in diameter.

Note form and color of the plant, the peculiar way in which the cap is convoluted, and also how it is attached to the stem at various points.

This plant is edible but the water in which it is first cooked is said to be poisonous. The plant should be first parboiled and the water thrown away.

The true helvellas belong in the genus Helvella.—Helvella lacunosa and *H. crispa* are common species. They occur during the summer. The first is usually dark gray, the second is entirely white. They may be known by the stems which have deep longitudinal furrows or lacunae side by side and overlapping, and no single one extending the full length of the stem, though some furrows are nearly as long as the stem. The plants are one to three inches high, the stems about one-half inch in diameter. If the plants are found, compare them with the *Gyromitra.*

Helvella infula is a large plant, dark brown in color, and the cap is somewhat convoluted, resembling the *Gyromitra.*

SUMMER CUP FUNGI.

There are a great many summer cup fungi which grow on ground, or on sticks, weeds, rotting stumps, logs, etc., and even on dung. Some are quite small, and the various kinds vary from the size of a pin-head up to two to four inches in diameter. Observations can be made on different kinds, noting size, form, color, presence or absence of hairs, etc., and their habitat, *i. e.,* where and on what they grow.

There is one large cup fungus which can sometimes be readily grown in greenhouses during the winter. I have for several years observed that *Peziza vesiculosa* grows on excelsior when that is packed on the ground in our greenhouses between boxes or pots where it is kept rather damp by moisture from manured soil. The cups in this plant are often two to three inches in diameter, sometimes several growing together.

THE POWDERY MILDEWS.

These are very common fungi parasitic on leaves, stems and fruits of many cultivated and wild plants. The mycelium of most of the species grows on the outer surface of the host (the host is the plant on which the fungus is parasitic) where it forms delicate cobwebby white threads. These threads form erect branches which divide up into a necklace-like chain of spores or conidia which are white and produced in such numbers as to give the leaf or stem the appearance of having been powdered.

The common lilac, the choke cherry, elm and oak leaves, willows, etc., are very commonly affected. When the leaves are well powdered examine them with a hand or pocket lens. With care, the delicate necklace of white conidia can be seen. In a somewhat older stage search for minute black bodies which are often thickly scattered over the affected parts of the leaf and are especially prominent on the white mycelium. They can be seen with the unaided eye. Examine these with a hand lens. There will be seen slender black branches or "appendages" bristling all round the black body which is the fruit body. If it is on the lilac, choke cherry, or oak these appendages will be forked several times at the end in a dichotomous manner with recurved tips; if on the willow or elm they will probably be coiled at the tips. These fruit bodies contain inside delicate sacs, each of which contains several spores. These are known as the winter spores. They live through the winter and reproduce the fungus again in the spring, while the conidia are the summer spores and serve to propagate and spread the fungus during the summer.

THE BLACK FUNGI.

These have black fruit bodies which are more or less flask-shaped. The mycelium in most cases lives inside the hosts or substratum on which the fungi grow. The fruit bodies in some are scattered, and immersed more or less in the substratum, or are free on it; in other cases the fruit bodies are crowded together, or sunken in black crusts of mycelium; or in still other cases there is a mycelium body, or stroma, which is elongated and elevated from the substratum like a club, or branched, resembling the "fairy" clubs in shape. The fruit bodies here are immersed in these clubs or, more rarely, rest on the outside. Some of these fungi are parasitic, but a large number of them grow on dead wood, leaves, etc.

The black knot (*Plowrightia morbosa*) forms knots on the limbs of plums and cherries. During the winter examine these knots with a hand lens to see the crowded, black, roundish fruit bodies. These contain the winter spores which are ripened usually in February. In June examine the knots with a lens and note the velvet-like covering. This velvet-like growth consists of numerous erect black branches of the mycelium which bear summer spores.

The black rot of grape is one of the black fungi. In the woods most of the black " fairy " clubs (*Xylaria*) are also black fungi. Many of them, however, are earth tongues (*Geoglossum*) and a very few are clavarias.

NEEDED IMPROVEMENT IN EXPERIMENTAL WORK IN SCHOOLS.

BY JEAN BROADHURST,

New Jersey State Normal and Model Schools.

Much of the work in experimentation as it is now conducted in the teaching of the various sciences defeats its own aim—the development of independent thought and of the attitude of the investigator and inventor.

I do not refer to the older type of experiment work where the pupil is required to follow a set of clearly-defined directions to attain a result defined even more clearly. We are fortunately past that stage.

The methods now in general use are much sounder in principle. Our high school text books contain definite directions for experiments, but ask the pupil to interpret the results, so as to arrive at certain conclusions or establish important rules or principles. This is certainly an undoubted advance. Does it, however, accomplish its own aim? How often have you seen a pupil complete the prescribed directions and fail to interpret the result? Urged, how often does he answer, " I don't understand it "? This state of affairs is not uncommon. I have seen it even in Junior classes in college. Why?

Often, because the apparatus is too complicated to serve as a *means* to an end; often, because it demands technical knowledge and definite manipulation beyond the ability of the average pupil; more often, because the pupil is more concerned in " doing the experiment " than in the search for the truth itself. Science, like arithmetic, becomes mere " getting the answers "; any science approached in this way deteriorates into a series of difficult puzzles and guessing the answers to these soon becomes a tiresome affair. This can be avoided. More than that, experimental work can be so managed that it will satisfactorily meet the present objections—the expensive apparatus demanded and the great length of time necessary to acquire even a little knowledge at first hand.

Work in grammar and high school classes during the past two years has shown great gain when directions were not given but the *question* put directly to the class, is:

Has air weight? Is liquid pressure the same at all depths? Do plants breathe as animals do? What influence does light have upon stems? What part of the plant gives out water? The opinions advanced by various pupils were discussed. Sides were taken, often. Next followed the questions, " How can we find out? " or " How can you prove that is true? I don't believe it." Then, from the pupils came the directions for the experiment—some workable—others not, but by the time the directions suited the majority of the class they were usually in surprisingly good form. Often initial statements were given by the teacher, as the effect of the breathing of animals on pure lime water in answering part of the third question above given. The rest was left to the class. " That will keep out the light but not the air," " You'll have to seal it or more oxygen can come in," " That won't be fair, for it has less air than the plant in the light," " That won't prove it unless you weigh it before and after, both," " That won't show that the stem doesn't give out water, too," are a few of the criticisms by the pupils. At last, one or two members of the class set up the experiment and when ready reviewed the question and the method, and interpreted the results. If the result is surprising, a text-book is consulted; should there be a difference the experiment is gone over carefully to see whether the book is wrong or whether some joint has not been made air tight; whether the water supply proved insufficient for full development, etc., and the experiment is made again under the improved conditions. A boy in one class found to his surprise that seeds grow better when left with but half of the food material. The class refused his results at once, pointing out that he had used soil for the various seeds, and that it was unequal in amount and moisture.

A pupil who can suggest an experiment is pretty sure to know what the experiment shows. The knowledge gained is definite; if forgotten, it is more easily reasoned out by him or the experiment can be readily performed again. Can we say as much for the ordinary pupil if deprived of his experiment book? A pupil so trained looks past the mechanism to the result; things are spoken of in terms of their direct use; this paper disk becomes "something to keep out light," the bell jar, "something to let in light but not air," the bent glass tube, "something to carry water," etc. Home-made apparatus is made and used, for the pupil does not ask for a clinostat, but hunts for something that will "keep turning round." Such a pupil must be more critical in accepting the results of others and the methods by which they were reached, and more can be gained from books, for the pupil of to-day can not afford to travel as slowly as did the race. The experiments demanding technical skill may be performed by the teacher at a great saving of time. Above all, the experimental work the pupil does do is accomplished in the same way in which it was originally done by the scientists we would have him emulate; he actually becomes an original investigator and an independent thinker, and the search for the truth because it is the truth (and not because it is the answer) is the end kept preeminently before him.

VARIATIONS IN TRILLIUM.

By Lester B. Gary.

Foster Flats are situated a short distance below the Whirlpool of Niagara River. They consist of limestone (Niagara and Clinton) debris that has accumulated at the foot of a shallow fall before the Falls had receded to their present position. The exposure is southeast.

The broken surface, the rich soil, the abundant moisture, the westerly protection of the Gorge wall, are some of the ecological factors favorable to the development of a rich flora in which the genus *Trillium* is very prominent. *T. grandiflorum* is present in unwonted profusion.

Trillium erectum is found growing very large. One specimen on a rocky hummock had cream-colored petals and diminished odor, and the ovary alone retained the characteristic red color. There are numerous variations of *T. grandiflorum* both progressive and retrogressive.

The most striking variation of the flower is the development of chloryphyll along the midvein of the petal. This may be arranged in a narrow strip in herring-bone pattern, or it may be a broad solid stripe of green about two-thirds the width of the petal, or it may cover the entire petal except two narrow white stripes on the edge near the end of the petal. Correlated with this, there is usually an increase in the size of the sepals. If flowers are modified leaves, then this appears to be a reversal to type. Nature seems to have turned back a few pages of her book, and displayed a few of her earlier designs. In some, the portions of the petals that are white turn pink with age, as is usual, and shrivel, while the green part of the petal may be tinged with pink, but does not shrivel so quickly, showing that it has some functional importance. The transplanted specimens died down after a short time so that the length of persistence of the petals was not noted.

This development of chloryphyll in the petals and the widening of the sepals has gone so far in one case as to do away with the three characteristic stem leaves of the *Trillium,* allowing these modified flower parts to serve the entire function of leaves. It strongly suggests the tulip plan of flower without the basal leaves.

At the other extreme of variation or, perhaps, intermediate between the last form and the usual *T. grandiflorum,* is one in which the three stem leaves have progressed by developing petioles one-half to one inch long, although this has been accompanied by a reduction in the size and in the shape of the leaves.

Specimens with supernumerary and poorly developed parts occur. Probably in some of these, gradation between stamens and leaf-like structures can be found. One example of a striking variation was discovered in which a perfectly white *T. grandiflorum* had so far diverged from the habit of the family as to have four petals, four sepals, and four stem leaves.

Those forms in which retrogression has not been so great as to do away with the formation of seeds, may afford good material for the study of heredity.

EDITORIAL.

THE FORESTRY BUILDING AT THE LEWIS AND CLARK EXPOSITION.

Everyone who has visited the Lewis and Clark Exposition at Portland, Oregon, has surely been deeply impressed by the beauty and wonder of the Forestry Building. It was eminently fitting that this building should typify the great forest resources of the Northwest, and so well was this done that it was the real center of attraction to visitors. A description of the Forestry Building is unnecessary here since it has become familiar through the press to all of us. The issue that is now before the Commissioners is the proposition to preserve the building intact as a permanent source of instruction and as an adornment of the city of Portland. It would certainly be a matter of regret if this were not done. It would, we are sure, prove to be a subject of interest to every visitor to Portland, and would speak eloquently of the wealth of the great forests of the Northwest.

While complimenting the city of Portland on the possession of such a unique and really valuable trophy of her exposition, we should not forget to do justice to the man whose mind conceived, and those untiring effort and unflagging interest brought the building into being and carried it to its final perfection. Mr. Edmund P. Sheldon has before shown his ability as an exhibitor of forest products, and we recall the excellent showing of the forest products of Oregon made under his direction at the Louisiana Purchase Exposition. But in the Forestry Building at Portland Mr. Sheldon has outclassed every forestry exhibit of the past. We venture to express the conviction that the city of Portland would make a great mistake if this magnificent structure were allowed to be destroyed.

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

THE VITALITY OF SEEDS.—Considerable misconception exists in the lay mind concerning the length of time that seeds will retain their power to germinate. Stories of the germination of wheat grains preserved for thousands of years with Egyptian mummies though widely circulated, are not well authenticated.

In the August (1905) number of the *Botanical Gazette,* Professor W. J. Beal, records experiments on the vitality of seeds, begun by him twenty-five years ago. Twenty lots of fifty freshly grown seeds each, from twenty-three different kinds of plants were placed with moist sand in a pint bottle. The bottles, uncorked, and with the mouth slanting downward to prevent the accumulation of water, were placed in a sandy knoll about twenty inches below the surface. Sets of seeds were tested for vitality at the end of five, ten, fifteen, twenty, and twenty-five years.

Of acorns, which were placed in soil near the bottles, but not in them, all were dead at the end of two years. Eight out of twenty-two species failed to germinate at the end of five years and at each test thereafter. There were *Ambrosia artemisiaefolia, Bromus secalinus, Erechthites hieracifolia, Euphorbia maculata, Lychnis Githago, Quercus rubra, Thuja occidentalis,* and *Trifolium repens.*

Seeds from eleven species germinated after twenty-five years. Among these were *Brassica nigra, Capsella Bursa-pastoris, Oenothera biennis, Rumex crispus,* and *Portulaca oleracea.*

Some seeds of red clover kept for twenty-two years, for a time exposed to light, and for some years kept in a dark closet in a well corked two-ounce bottle germinated. The percentage was very small, less than 2%. C. S. G.

RAISING CORN IN THE LABORATORY.—In view of the fact that the maize or Indian corn furnishes a large proportion of our cereal products and so enters intimately into the life of man, it must be conceded that the study of its life history is valuable to students in our secondary schools. The storage of food outside the embryo, the correlation of single cotyledon and parallel veined leaves, the development of brace roots, jointed stems and the non-branching habit are all familiar facts to be brought out in this plant.

Comparatively few people know that the tassels of Indian corn constitute the staminate flowers and that the silk are the stigmas of the pistillate flowers. In this connection it may be of interest to teachers of botany that corn plants germinated in the laboratory and transplanted to flower pots in the Wardian case were brought into flowering condition. Restricted soil area and the limited amount of sunshine of the short winter days resulted in formation of dwarf plants, but notwithstanding the dwarf habit, they showed excellently all the important facts to be brought out in the study of Indian corn.

When only a few inches high brace roots were put out and when only fifteen inches high staminate flowers began to develop. A week or two later the pistillate flowers and embryo ears began to show. Whether ears would have ripened was not ascertained, as all the plants were used for the demonstration of the position, formation and development of the floral parts. Enough plants were grown for all the tables in the laboratory, the living material being supplemented by stalks, staminate, pistillate flowers and ears of green corn preserved in formalin. A matured dried plant saved from the autumn harvest was exhibited to show the size the plants would have attained under favorable conditions. At this time also the necessity of proper soil and abundance of sunshine for photosynthesis was emphasized.

It is always easy in going through a corn field to find flower clusters containing both pistillate and staminate flowers. Such are often found on plants attacked by the corn smut, the regular processes of the plants being interfered with by the parasite. Material of this preserved in formalin was also shown as examples of the frequent variation to be met with in nature.

As corn in the field is only a few inches high in our latitude in June, and as also at that time we have a profusion of other material, the advantages are obvious of studying in the winter the complete life history of such a plant as the Indian corn after the separate consideration of structure and function of root, stem and leaf.

MABEL L. MERRIMAN.

CATCHING FISH WITH INTOXICATING PLANTS.—A novel method of catching fish, employed by the natives of Guam, is thus described by William E. Safford (Nat. Geog. Mag. **16**: 233, 1905).

The fruit of a common tree (*Barringtonia speciosa*) "is pounded into a paste, inclosed in a bag, and kept over night. The time of an especially low tide is selected, and bags of the pounded fruit are taken out on the reef next morning and sunk in certain deep holes in the reef. The fish soon appear on the surface, some of them lifeless, others attempting to swim, or faintly struggling with their ventral side uppermost. The natives scoop them in their hands, sometimes even diving for them.

"As many young fish unfit for food are destroyed by this process, the Spanish government forbade this method of fishing, but since the American occupation of the island the practice has been revived." C. S. G.

A CHEAP AND SIMPLE ROOT CAGE.—The usual form of root cage in use is usually a box with an oblique glass side through which the growth and movements of roots may be observed. A much simpler and less cumbersome piece of apparatus and one which has other advantages to boot may be constructed from a sheet of glass, some stiff paper, paraffin, string and sphagnum moss, chopped and well washed. The paper should be rendered waterproof by means of the paraffin, by applying it with a hot iron. The glass having been cleaned, the moss is laid upon it to the thickness of an inch and the paper is then wrapped about the whole so as to make a pocket, leaving the glass free except along a narrow strip about three edges. The hole is held together by the string. Seeds may then be planted upon the open edge of the moss and the subsequent behavior watched. The advantage which this arrangement has, beyond the simplicity of construction and slight cost, lies in the ease with which it may be placed in any position. It is further one which many pupils may construct for themselves and so carry out experiments independently. L.

A SIMPLE MODIFICATION of Detmer's experiment to demonstrate the need of light for photosynthesis is given by King in *Torreya* for April, 1905. Miss Haug (*Bot. Gaz.*, November, 1903) has called attention to a source of error in the experiments as described by Detmer, where two pieces of cork are pinned opposite to each other on the two surfaces of the leaf. By this arrangement there is a possible exclusion of carbon-dioxide as well as of sunlight. The modification proposed by King is to substitute for the corks "narrow strips of black cloth about as coarse-meshed as cheese-cloth." By this means the carbon-dioxide finds ready access to the tissue by diffusion through the cloth, while light is effectually excluded. No starch is formed under the strips of cloth. C. S. G.

REVIEWS.

Organography of Plants. By Dr. K. GOEBEL. English translation by Isaac Bayley Balfour. Oxford: The Clarendon Press. Part I. General Organography. Pp. xvi + 270. 1900. Part II. Special Organography. Pp. xxiv + 708. 1905.

Organography and plant physiology are closely interwoven departments of botany. We may study the effect of various factors of environment on the structure and function of plants, or we may restrict our field and change our view-point, confining our study to the organs of the plant and endeavoring to explain the observed facts. The latter is the scope and point of view of Dr. Goebel's two volumes. The keynote to the work, stated in the preface to Part I, is that "the configuration exhibited by plants is a part of their life phenomena," and, "that to recognize the factors which bring about the development of say a leaf with one side larger than the other is infinitely more important than to construct a phylogenetic hypothesis unsupported by facts." Of course the method is that of experiment.

Part I deals with general principles. Part II gives the experiments and facts upon which the principles are based. Every page is of interest. Besides being a monumental contribution in itself, the work will be of great value as a stimulus to further research. It will have special value for teachers, correcting many false or inadequate notions, and suggesting many problems which may be undertaken and successfully prosecuted without the aid of costly apparatus and elaborate technique. The book covers the entire range of the plant kingdom. Every advancing teacher should become, not only familiar with its pages, but imbued with its spirit.

C. S. G.

Outlines for Field Studies of Some Common Plants. 2d Edition revised. 51 pp. 12mo. By C. H. Robison. Privately printed, Oak Park, Ill.

Many teachers are familiar with the author's first edition of this work and will welcome the fuller revised form in which it now appears, and which deserves wide circulation and a thorough trial. The outlines are, for the class of pupils for which they are intended, sufficiently difficult—certainly they are not too difficult—and compass a very fair amount of work. Part of the studies called for are of the nature of experimental ecology to be carried on in the field. As an example of this one may cite the first lesson on day and night positions of the clover leaf—one of the best of them all. One might wish that the spirit of this exercise were more evident throughout, for in it the author strikes a distinctly modern note in botanical pedagogy: the plant is to be viewed as a living thing. Other parts are somewhat more commonplace in the sense that they differ less from the usual text book directions. They, however, doubtless serve a purpose of convenience in the scheme. Those teachers whose experience has not made them familiar with field methods or who are casting about for suggestions for the formulation of outlines for field excursions will find a material help in the pages here briefly reviewed. A second part, which we have not seen, is entitled "Spring Flower Studies," and appears separately bound.

My Own Book of Three Flowers which Blossom in April. My Own Book of Three Flowers which Blossom in May. By Anna Botsford Comstock. New York: American Book Co. 1904. 30 pp. each, bound in one pamphlet.

Embodies a unique idea in nature study. The April flowers are *Hepatica,* Spring-Beauty, and Adder's Tongue. The May flowers, Squirrel Corn, Jack-in-the-Pulpit, *Trillium.* For each plant a series of questions are asked, the answers to which the pupil must find in the specimen itself. There are blank pages for additional notes, and leaves of drawing paper for sketches. Conventional decorative designs made from each plant are given, and the pupil is expected to originate others. Thus correlation with drawing is secured. A very attractive and practical little pamphlet.

G. S. G.

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THE MISTLETOE: SOME RECENT OBSERVATIONS ON ITS HABIT AND STRUCTURE.

WITH ILLUSTRATIONS BY THE AUTHOR.

BY MARY M. BRACKETT.

During one season, at least, the Mistletoe holds its own among popular plants, and several thousand dollars are expended annually in supplying the demand for this interesting parasite. The white-berried twigs that we suspend from our chandeliers at Christmas-time are gathered from old apple trees in the farming districts of England. The plant is known to botanists as *Viscum album,* of the family Loranthaceae. Tradition has it that the Mistletoe is native to English oaks; but in reality it is distributed throughout Europe from the Mediterranean to the Scandinavian peninsula, and as stated in Kerner and Oliver's Natural History of Plants, its favorite hosts are the black poplar and the pine, or, where these are wanting, the ash, elm, willow, walnut, or lime. But only by exception is it found upon the oak.*

Although *Viscum album* is the one true "Mistletoe," the name is applied generally to the other members of this family, some of which closely resemble the imported variety, others differing widely. The number of species is about 500. *Loranthus Europaeus,* parasitic on oaks and chestnuts in the south of Europe, is a species with yellow berries. On the Mediterranean coast grows the Juniper-Mistletoe, *Arceuthobium oxycedri,* which has oblong blue berries, and its foliage leaves reduced to little scales.

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* Kerner and Oliver. Natural History of Plants, 1: p. 205, 1895.

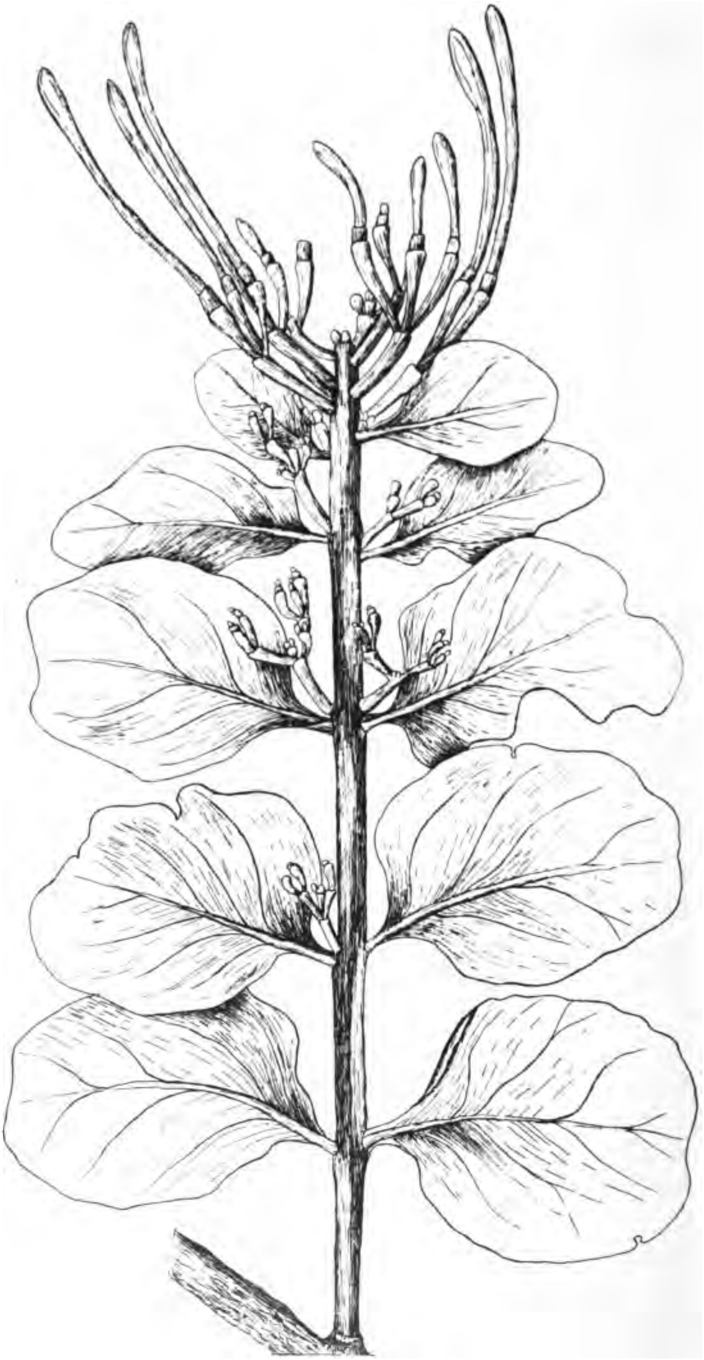

FIG. 51. *Psittacanthus claviceps* Urban. The long, tubular corolla is yellow, tinged with red. Monoecious. Jamaica, B. W. I.

Other leafless forms exist also in India, Japan, Java, Mexico, and in South America.

In this country, the False or American Mistletoe, *Phoradendron flavescens,* which resembles *Viscum album* grows on deciduous trees from the pine barrens of New Jersey to the mountains of North Carolina and westward to Ohio and Missouri. This, too, has commercial value and is sent to the northern markets, but it is not so handsome as its English cousin. In the winter of 1871 a tiny mistletoe, *Arceuthobium pusillum,* was found growing on the black spruce in Warren and Renselaer Counties, New York. This discovery incited collectors to hunt for new stations for the plant, with the result that it has since been found in the Adirondacks, in Maine, Vermont, New Hampshire, Massachusetts and Pennsylvania. The mistletoe in all these localities occurs chiefly on the black spruce growing in sphagnum bogs. Mr. J. G. Jack thus describes it:* "This mistletoe is dioecious and the staminate and pistillate flowers are usually found on separate spruces, but sometimes on different branches of the same tree. At maturity this little parasite rarely approaches an inch in length; most commonly it is less than half an inch long." In the vicinity of Tucson, Arizona, a semi-desert country, occur several species, among them *Phoradendron villosum* and *P. californicum.* The former has white berries and broad leaves, and grows mainly on the native ash and cotton wood. It is also found in California. The latter species has red berries and is nearly devoid of leaves. It hangs from the branches of its host, the cat-claw, the mesquite, or the palo verde. Along the rims of cañons in this region occurs *Razoumofskya robusta,* destructive to pine trees. Certain species of *Arceuthobium* are native to the Pacific coast, one species being an enemy of the Monterey pine.

The island of Jamaica in the British West Indies is a spot rich in Loranthaceae, especially in the mountains. As one ascends from valley to mountain peak, the mistletoe may be discovered, now on a wayside bush, and now among the highest branches of a tall tree. And unless one looks sharply he may miss it altogether, intermingled as it is with the dense verdure of its host. On a recent visit to the Laboratory of the New York Botanical Garden at Cinchona, the writer brought back twelve species, all differing greatly from one another in respect to leaves, flowers, and fruit, the berries showing a great variety in color—white, yellow, green, scarlet, orange, and purple.

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* Rhodora, 2: 13, Jan. 1900.

It is apparent, then, that the members of the family Loranthaceae are widely distributed all over the world; that they favor no one tree as host; that they flourish in divers climates—in the temperate countries of Europe and our own seaboard states, in the colder climate of New England, in the dry air of the "American Desert," and in the warm, moisture-laden atmosphere of California and the tropics; and that they grow, also, in many altitudes, from sea level to an elevation of 6,000 feet.

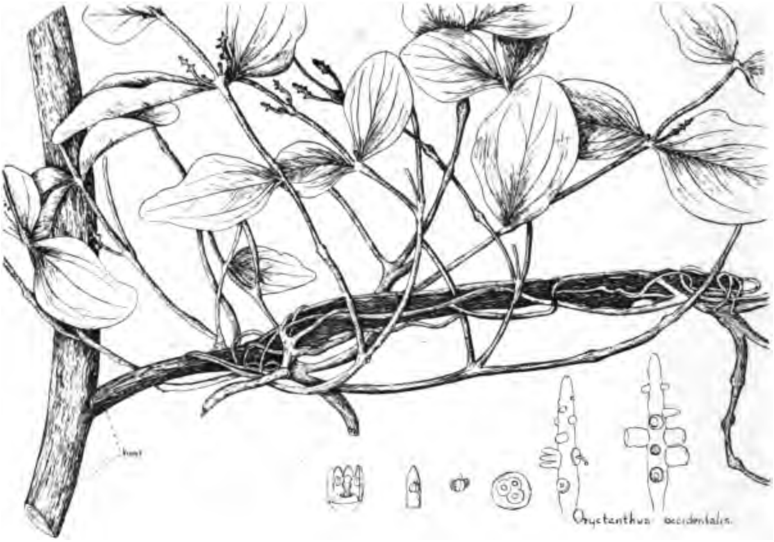

FIG. 52. *Oryctanthus occidentalis* Urban. The rusty brown branches entwine the host branch, and send out haustoria which form knobs where host and parasite meet. The flowers are small, in spikes, sunk in excavations of the rachis. The berries are dark purple, turning black. Jamaica, B. W. I.

Botanically, the mistletoe is a plant of unusual interest, and its curious mode of life, and the fact that it has a peculiar structure have been familiar to botanists for many years; but up to the present time more is known about its parasitism and the dissemination and germination of its seeds than about its internal anatomy. The first published observations on the Loranthaceae appear to have been made early in the last century by a French botanist named de Candolle. In a memoir on the subject written in 1830 he says: "The strangeness of their vegetation, and the diversity of their forms make it desirable that hereafter the Loranthaceae should be less neglected, and I would urge all travellers and sedentary botanists in countries rich in Loranthaceae to have regard in their researches to the following points: note the species of tree on which are found each species of Loranthaceae; where the whole host plant cannot be observed, preserve pieces of it; note the mode of adherence to the host plant; gather the flowers and fruit which are rare in botanical collections and of which there are few figures and descriptions complete; note physiological experiments on the white mistletoe, the indifference to the vertical direction, the number of embryos in a seed, the direction of the radical, etc.; prove whether the young ovaries present many locules or many ovaries."*

The distribution of mistletoe is usually attributed to birds—particularly thrushes—which feed upon the berries and allow the undigested seeds to pass through the alimentary tract; or, as Reiche says of a South American mistletoe: "The bird [thrush] is accustomed to sit upon a cactus thorn, and after eating the slimy part of the pericarp, to wipe off the sticky remainder on the nearby spines."†

Von Schrenk says‡ that birds must have carried the seeds of *Arceuthobium pusillum* from the Mainland to Monhegan Island, Maine.

A different method of seed dissemination in *Razoumofskya robusta* has been described by Dr. MacDougal.§ Here the scattering of the seeds is brought about by a mechanical contrivance within the fruit. About the time the seed is ripe, a layer of long thin-walled cells near the apex of the berry become filled with water. The increase in turgidity of this, the expulsory layer, causes a strain on the layer of cells at the point where the berry is attached to its stem. This scission layer, as it is called, is rup-

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* de Candolle, A. P. Mémoire sur la Famille des Loranthacées. Paris, 1830.

† Reiche, K. Bau und Leben der chilenischen Loranthaceae, *Phrygilanthus aphyllus.* Flora, **93**: 271. 10 August, 1904.

‡ Rhodora, l. c.

§ MacDougal, D. T. Seed dissemination and distribution of *Razoumofskya robusta.* Minn. Bot. Studies 2 Series, pt. II, pp. 169–173, 1899.

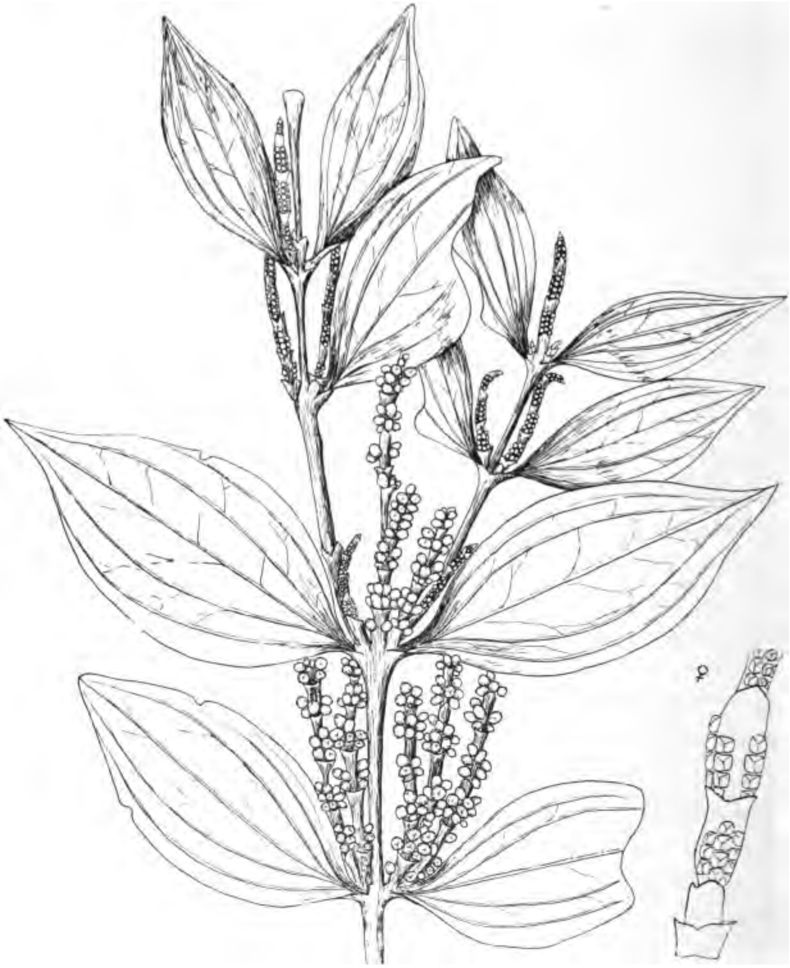

FIG. 53. *Phoradendron flavens* Urban. Flowers monoecious. The fruit a bright yellow, in long spikes. Jamaica, B. W. I.

tured by the pressure from within, and at the same time the seed is expelled. Dr. MacDougal thus describes the phenomenon: "One may stand under a pine tree on a quiet morning and hear the sharp click accompanying the expulsion of the seeds from the berries at irregular intervals. If the branches are jarred or shaken, however, the irregular explosions give way to fusillades by which nearly all of the berries on a plant will be set in action at once. The expulsion of the seed occurs as soon as the berry has broken loose from the stalk, and as these berries were originally in all positions the seeds are sent out in all directions. . . . The only part that animals play in the dissemination of the seeds would be in causing the discharge of the berries, a matter of no direct value, since they are capable of quite as efficient action independently. The berry of *Razoumofskya* is, therefore, to be classed as a sling fruit." A similar method of dissemination has since been described by Mr. George J. Peirce* in *Arceuthobium occidentale,* and it has been observed, also, in the New England mistletoe, *Arceuthobium pusillum.*

Collectors of mistletoe have noticed that the seeds will germinate on almost anything—bark, branches, leaves, pine needles, a cactus thorn, a board fence, or a barbed wire, anywhere, so long as the air is moist. Of course, germination will not be ultimately successful unless the seed fall upon a tree trunk or branch.

When the seeds fall they become firmly attached to the host by means of their mucilaginous coating. The hypocotyl then makes its appearance and always turns toward the host. When it has reached the bark it becomes pressed and cemented to the surface, and flattens into a disc-shaped organ (Figs. 54, 56, 57).

Reiche thus describes a very unique process which takes place in the course of germination of the Chilian mistletoe, *Phrygilanthus aphyllus,* parasitic chiefly on a species of cactus: "The radicular end of the embryo which has been affixed perhaps at some distance from the surface of the epidermis of the host plant, probably on a thorn, elongates to an extraordinary length, which varies more or less according to circumstances. If the seed has been placed high up on a long thorn, the lengthening of the embryo may go on until the endosperm is exhausted, and so the plantlet dies without making its goal. Under these circumstances the length attained may be 6 to 8 cm. The embryo may grow straight, or it may wind more or less about other spines which perchance it meets in its way (Fig. 55), and then the projecting papillae with which the radicle is supplied may serve as supporting or clinging organs. At the same time the root end of

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* Peirce, Geo. J. The Dissemination and Germination of *Arceuthobium occidentale,* Ann. Bot. **19**: 99–113. January, 1905.

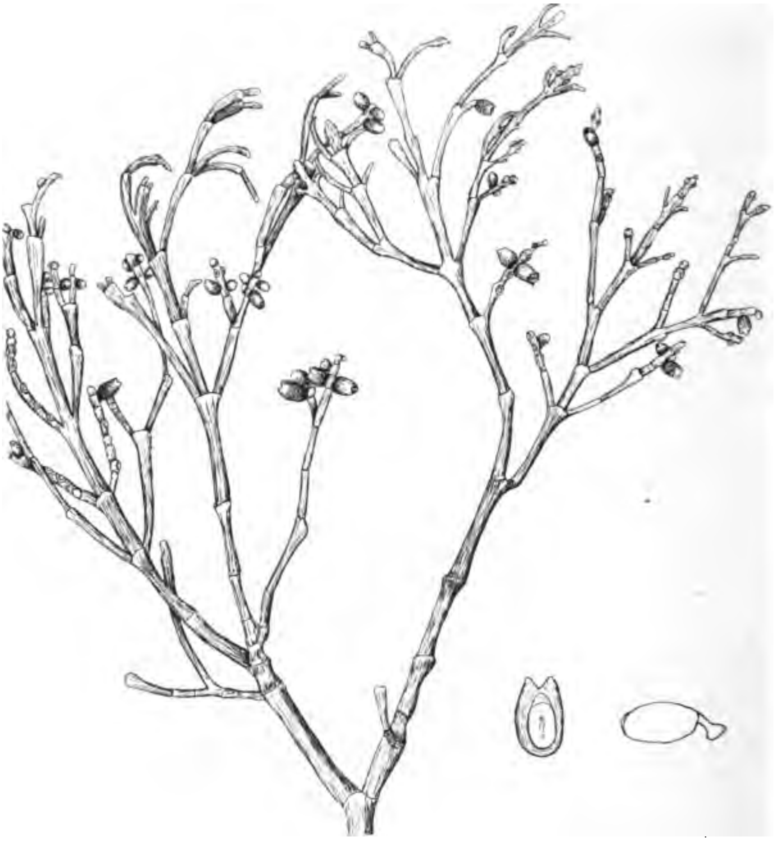

FIG. 54. *Dendropthora gracilis* Urban. Found growing on a juniper in Jamaica. The leaves are reduced to scales. The flowers are dioecious, in spikes. The berry is red. (*a*) Longitudinal section of berry, showing seed enclosed in the fleshy pericarp. (*b*) The seed germinating; the end of the hypocotyl has broadened into a disc.

the embryo swells up, and becomes supplied with a crown of crowded hairs. This structure is the adhesive disc common to the members of the Loranthaceae. The swelling continues until it takes a symmetrical oval form, on the surface of which are to be seen the upwardly directed projections. While the adhesive disc develops in size, the elongated connection between this and the seed gradually withers away. Up to this time, however, it has served as an absorbing organ, taking the food from the endosperm and bringing it to the developing distal portion which, as pointed out, becomes swelled up into an oval mass, and now becomes attached to the epidermis of the cactus host."

The disc-shaped organ mentioned above serves both as a holdfast and as a secreting organ for an enzyme which aids in the penetration of the host by the haustoria. Dr. Cannon describes the entrance of the parasite (*Phoradendron villosum*) into the host: " The branches [of the ash] are provided with prominent lenticels and if one of these chances to be directly beneath a disc, the epidermal cells of the disc enter it, dissolving or pushing to one side, or both, the cells of the host, and at length find themselves in the cortex. This is not a matter of solution entirely, since the host-cells at the side of the haustoria give evidence of

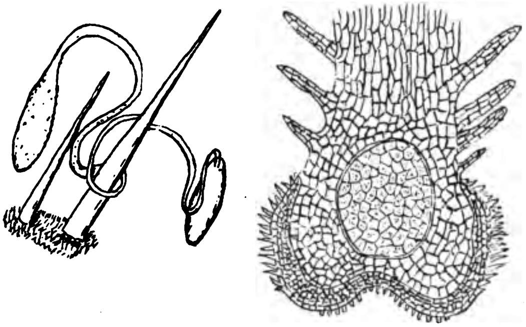

FIG. 55. Germination of *Phrygilanthus aphyllus*. (*a*) The seed is stuck to the epidermis of the cactus, and the embryo winds about the thorn until its radicle end, swelling up to the disc, again reaches the epidermis. (*b*) Longitudinal section through the lower part of an elongating embryo. The plasmatic contents of the cells is pictured only in the central meristem. After Reiche in Flora.

having been subjected to pressure by them, and the walls of such cells are suberized. . . . the solvents secreted by the haustoria of the parasite do not dissolve suberized walls, and apparently cannot do so."* Dr. Cannon emphasizes the fact that the haustoria never penetrate farther than the cortex, but Peirce pictures the haustoria of *Arceuthobium occidentale* as having passed the cambium and penetrated the wood through a medullary ray.

While the haustoria are spreading in the interior of the host, the vegetative portion of the parasite grows upward from the bark; the cotyledons are detached from the sticky seed-coat; branches grow out from buds, and soon we have a flowering plant, as well able to form chlorophyll, to assimilate its food, and to reproduce itself as any other phanerogam, but unable, because deprived of true roots, to obtain water from the soil.

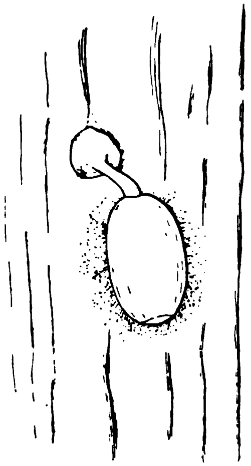

FIG. 56. Seedling of *Dendropthora gracilis* germinating on a juniper branch, Jamaica, B. W. I. The end of the hypocotyl has been transformed into an adhesive disc. The seedling is surrounded by a sticky substance.

An interesting feature of the mistletoe is its influence on the host plant. Often the tissues of the host in the region of the parasite show abnormal structures, the branches are stimulated to increased growth, while the development of the nearest buds may be checked or altered. A common type of abnormal growth is a bunch of small, upright branches forming a " witch's broom." This abnormal growth was not observed on any of the mistletoe-bearing trees or bushes in Jamaica, nor did the host plants seem to suffer in the least; yet the pines in this country gradually die from the effects of the parasite.

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* Cannon, W. A. Bull. Torrey Club, 31: 435–443. August, 1904.

The embryo of the mistletoe, as it lies within the pericarp, is a bright green because of the abundance of chlorophyll which it contains. It does not undergo any period of rest, but is ready to continue its growth as soon as it falls on a suitable substratum. The question is still to be settled whether the " seed " of the mistletoe is a true seed, a naked ovule without integuments, or rather a naked embryo enclosed in a fleshy pericarp. As for the embryology of the parasite, nothing more is definitely known concerning it than in the time of de Candolle, largely because of the rapid disintegration of the delicate cells of the young flower in the process of " fixing," a trait peculiar to parasitic plants. When the history of the embryo-sac is worked out, it may throw some interesting light on the physiology as well as on the morphology of parasites. It is a problem on which the writer is at present working.

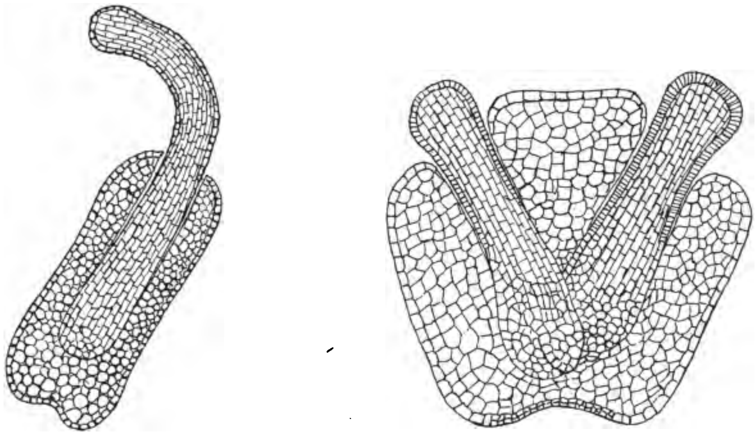

FIG. 57. Seedlings of *Viscum album*. (*a*) Containing a single germinating embryo. (*b*) Two germinating embryos. The cotyledons of one of them can be made out. From preparations by Professor F. E. Lloyd.

THE PLANT FORMATIONS OF THE CATSKILLS.

By Professor John W. Harshberger,

University of Pennsylvania.

Little has been published on the flora of the Catskill mountains. The three papers* on the vegetation of these mountains are merely annotated lists of the trees, shrubs, ferns and mosses: Presumably collections of plants have been made, but no account of the plant formations has appeared.

According to the observations of the writer, there are some seven plant formations displayed in the Catskills. They may be enumerated as follows: deciduous forest formation, coniferous forest formations (three in number), rocky ledge plant formation, and lake and marsh plant formations.

Deciduous Forest Formation. The valleys and mountains, except the summits of the highest peaks, are covered to a height of about 3,500 feet, with a deciduous forest. It is a mixed forest consisting of such dominant trees as: *Fagus americana* (beech); *Castanea dentata* (chestnut); *Quercus rubra* (oak); *Juglans cinerea, J. nigra* (walnut sparingly present); *Betula lutea, B. lenta, B. populifolia, B. papyrifera* (birches, uncommon); *Acer saccharum* (=*A. saccharinum*), *A. rubrum* (maple); *Populus tremuloides, P. grandidentata* (poplar); *Ulmus americana* (elm); *Prunus virginiana* (choke-cherry, rare); *Tilia americana* (linden); *Tsuga canadensis* (hemlock); *Pinus strobus* (pine); *Hicoria glabra* (=*Carya porcina*), *H. ovata* (hickory). Near the streams in this forest are found *Platanus occidentalis* (sycamore); *Carpinus caroliniana* (hornbeam), and such shrubs, as *Alnus serrulata* (alder); *Hamamelis virginiana*

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* The only papers on the Catskill flora according to Dr. John H. Barnhart of the New York Botanical Garden are: Hall, J. K., Catskill Ferns, Bulletin Torrey Botanical Club, **38**: 39, 1874; Mearns, E. A., A List of Trees and Shrubs collected [in the Catskills]. Proceedings U. S. National Museum, **21**: 343, 1898; Britton, E. G., Mosses of the Catskills, Torreya, **1**: 84, 1901.

(witch-hazel); *Sambucus canadensis* (elder), and *Amelanchier canadensis* (June-berry). As secondary trees grow *Acer pennsylvanicum, Hamamelis virginica, Cornus florida* (dogwood); *Prunus serotina* (wild black cherry), and *P. pennsylvanica* (wild red cherry). The absence of *Liriodendron tulipifera* (tulip-tree), of many species of *Quercus, Hicoria, Ulmus, Magnolia,* etc., is noteworthy. As the botanist ascends the mountains to an elevation of 2,880 feet, the constitution of this forest type becomes more uniform by the disappearance of such trees as the chestnut, oak, linden, walnut, elm, etc. At the head of Big Indian Valley, for example, the forest consists of *Betula lutea, Fagus americana* (= *F. ferruginea*), *Acer saccharum* (= *A. saccharinum*), and *A. rubrum,* with a sprinkling of *Tsuga canadensis* and an occasional *Betula lenta,* the undergrowth consisting of saplings of all these trees, associated with *Acer pennsylvanicum, Viburnum lantanoides* and *Taxus canadensis* (American yew). Here and there at this elevation, one sees the intrusion of *Abies balsamea* (balsam fir), *Picea mariana* (= *P. nigra*) (spruce), and *Sorbus* (*Pyrus*) *americana* (mountain ash).

In addition to the shrubs found near the streams, and mentioned above, the phytogeographer finds *Kalmia latifolia* (laurel); *Rhododendron* (*Azalea*) *nudiflorum, Ribes lacustre* (gooseberry); *Rubus villosus* (in sunny places) and *R. strigosus* (blackberry). The climbing vines are *Ampelopsis* (*Parthenocissus*) *quinquefolia* (Virginia creeper); *Clematis virginiana, Celastrus scandens* (bitter-sweet), and *Vitis riparia* (= *V. vulpina*) (wild grape). The herbaceous plants, or slightly woody plants of the forest floor, that exist in the shade of the broad-leaved forest trees, are: *Hepatica triloba, H. acutiloba; Uvularia sessilifolia* (bellwort); *Solidago caesia* (golden-rod); *Sanguinaria canadensis* (blood-root); *Geranium Robertianum, Eupatorium ageratoides* (white snake-root); *Viola palmata* (violet); *Monotropa uniflora* (Indian pipe); *Anemone nemorosa; Smilacina* (*Vagnera*) *racemosa* (false Solomon's seal); *Streptopus roseus, S. amplexifolius* (twisted-stalk); *Asarum canadense* (wild ginger); *Maianthemum* (*Unifolium*) *canadense* (ascending to considerable altitudes), *Corallorhiza odontorhiza* (coral-root); *Polygonatum* *biflorum* (Solomon's Seal); *Medeola virginica* (Indian cucumber root); *Erythronium americanum* (yellow adders-tongue); *Epiphegus virginiana* (beech-drops on beech roots); *Actaea alba* (white baneberry); *Caulophyllum thalictroides* (pappoose-root); *Dicentra canadensis, D. cucullaria* (Dutchman's breeches); *Viola-pubesceus, V. canina, Tiarella cordifolia* (false mitre-wort); *Mitella diphylla* (mitre-wort); *Aralia nudicaulis, A. hispida, A. trifolia, A. quinquefolia,* (wild sarsaparilla); *Aster cordifolius, Mitchella repens* (partridge-berry) (dry woods); *Trillium erectum, T. erythrocarpum, Aster acuminatus, Arisaema triphyllum* (Jack-in-the-pulpit). Associated with these plants are the following ferns and club mosses: *Aspidium aculeatum, A. intermedium, Cystopteris bulbifera, C. fragilis, Adiantum pedatum, Polystichum (Nephrodium) acrostichoides, Asplenium filix foemina, A. thelypteroides, Phegopteris polypodioides, P. dryopteris, Dicksonia (Dennstaedtia) pilosiuscula, Lycopodium lucidulum, L. dendroideum, L. clavatum* and *L. complanatum.**

The shaded swampy places in this deciduous forest are characterized by the ferns, *Osmunda regalis, O. Claytoniana,* and *O. cinnamonea;* by the Horsetail, *Equisetum sylvaticum;* and by the herbs, *Veratrum viride* (hellebore), *Thalictrum purpurascens,* and *T. dioicum* (meadow-rue), and in the shallow spring outlets, *Chrysosplenium americanum* (golden saxifrage).

CONIFEROUS FOREST FORMATIONS. These exist in three types determined by the dominant tree of each type. They are the hemlock (*Tsuga canadensis*) formation, the white pine (*Pinus strobus*) formation, and the balsam (*Abies balsamea*) formation.

HEMLOCK FORMATION. Formerly the hemlock, *Tsuga canadensis,* grew in considerable abundance in the Catskill mountains. It formed pure growths along the steep slopes of mountain streams, or on the northern shaded shoulders of mountain ridges descending into the principal valleys. It was much sought, as a bark and timber producing tree and much of the best hemlock has been removed long since from the Catskill forest. One isolated grove in Big Indian Valley was studied by the writer in September, 1905, and it may be taken as a type of the original hemlock formation. *Tsuga canadensis* is the dominant tree, covering in a close growth many hundreds of acres. It is associated with *Fagus americana* (= *F. ferruginea*), *Acer saccharum* (= *A. saccharinum*), and *Betula lutea*, which are sparingly present in this type of forest. On the ground the botanist finds: *Mitchella repens, Viola rotundifolia, Lycopodium lucidulum* (ground-pine), *Chimaphila umbellata* (pipsissewa), etc., while *Kalmia latifolia* forms the shrubby undergrowth.

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* I am indebted for some of the details presented here to Miss Lily Wells of Newport, R. I., who with her brother (now deceased) made water color paintings of Catskill plants; to Miss Martha H. Hollinshead, Moorestown, N. J., and to Dr. J. M. Macfarlane, University of Pennsylvania.

WHITE PINE FORMATION. At present this is found in a few localities and it represents largely a second growth in the wider valleys, not at any considerable elevation. As a formation, it occurs on the sunny, lower slopes of mountains exposed to the noonday sun. *Pinus strobus* is the dominant tree in pure growth, while beneath the pines, one finds much the same association of species as in the hemlock formation, herbs—such as *Gaultheria procumbens* (creeping wintergreen), *Chimaphila umbellata,* and *Pyrola rotundifolia* (wintergreen).

BALSAM FORMATION. Above 3,200–3,500 feet on the higher mountains, such as Cornell, Wittenberg, and Slide mountains, the balsam, *Abies balsamea,* forms an almost pure growth, associated with *Picea mariana* (= *nigra*), *Sorbus* (*Pyrus*) *americana, Betula lutea, Prunus pennsylvanica* and *Acer pennsylvanicum,* while the undergrowth of shrubs consists of *Viburnum lantanoides, Ribes prostratum, Sambucus racemosus, Rubus odoratus* (at lower elevations). The flowering plants of this forest formation are *Oxalis acetosella* (wood-sorrel); *Circaea alpina* (enchanter's night shade); *Viola blanda, Clintonia borealis, Cornus canadensis, Mitchella repens, Coptis trifolia* (goldthread); and *Corallorhiza multiflora;* the fern, *Dicksonia* (*Dennstaedtia*) *pilosiuscula,* the club moss, *Lycopodium lucidulum,* and on the mossy windfalls, *Cladonia rangiferina* with *Chiogenes hispidula* (snowberry). On the tops of the largest boulders occurs in dense mats the fern, *Polypodium vulgare,* and on the sides species of the lichen, *Umbilicaria. Vaccinium pennsylvanicum* (dwarf blueberry), arising from a mossy bed beneath the balsams, is a shrub from a foot to two feet high, and its position in the dense shade indicates the fact that on many of the mountain summits now denuded of their timber the blueberry thickets have been derived from shade-growing species of *Vaccinium,* that have adapted themselves to the changed environment. At lower elevations in this formation, one finds *Rhododendron* (*Azalea*) *viscosa,* and *R. nudiflorum.* On Slide Mountain at an elevation of 3,500 feet on cliffs and ledges under the balsams, *Abies balsamea,* were collected such mosses as *Raphidostegium Jamesii, R. laxepatulum, Plagiothecium striatellum, P. Müllerianum, Hylocomium umbratum, H. Pyrenaicum, Dicranum fusescens* and *D. longifolium.*

The balsam formation covers only the highest mountain peaks in the Catskills, viz., Wittenberg (3,824 feet), Table Mountain (3,875 feet), Cornell (3,920 feet) and Slide Mountain (4,220 feet), the latter the highest summit in the Catskills. It extends down the mountain slopes in tongues into the deciduous forest below and at lower elevations, it breaks up into isolated patches, easily delimited by the dark green color in a lighter green background. Its constitution is very similar to the topmost plant formations in the Adirondack mountains and in the mountains of Virginia, North Carolina and Tennessee.*

ROCKY LEDGE PLANT FORMATION. This formation is found on the rocky ledges and bluffs which occur throughout the Catskill mountains. The plants, which characterize such ledges, are mainly the ferns: *Camptosorus rhizophyllus, Pellaea gracilis, Woodsia ilvensis, Asplenium trichomanes, Polypodium vulgare,* and a few herbs, *Saxifraga virginiana, Arabis lyrata* (rock cress); *Aquilegia canadensis* (columbine); *Heuchera americana* (alum-root); *Polygonum cilinode, Campanula rotundifolia* (harebell), and various species of lichens, as of the genus Umbilicaria, and the blue green alga, *Nostoc* sp.

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* Harshberger, John W. An ecological Study of the Flora of Mountainous North Carolina. *Botanical Gazette* **36**: 376–381; Harshberger, John W. The Plant Formations of the Adirondack Mountains. *Torreya* V: 187–194.

LAKE PLANT AND MARSH PLANT FORMATIONS. The lake plant and marsh plant formations are sparingly represented in the Catskills. One natural lake, or mountain tarn, was noted as the source of Stony Clove Creek, already partially encroached upon by vegetation producing a marsh. Several other lakes exist in the region and also marshes, but in the absence of a detailed study, these formations are merely mentioned to complete our classification of the principal plant formations in the Catskill mountains. One other formation probably exists, as displayed on the bluffs at Kaaterskill (1,600 feet) overlooking the Hudson Valley, namely that in which the pitch pine (*Pinus rigida*) is the principal tree.

The original condition of the flora of the Catskills has been much disturbed by the removal of the marketable trees by lumbermen, and in the settlement of the country. The list of introduced plants is a large one, but by the process of exclusion due to long familiarity with the forests of eastern North America, the native plants of the Catskills and the constitution of the original plant formations have been determined without much difficulty.

THE INFLUENCE OF POLLINATION UPON THE DEVELOPMENT OF THE HOP.*

The main question which Mr. Albert Howard considers in an article with this title is whether pollination is necessary for best results in hop raising. Incidentally it suggests some interesting biological questions.

The hop vine is generally dioecious but occasionally monoecious in the Bramling variety. Male flowers occur in much branched cymose panicles. Each flower is about a quarter of an inch in diameter and consists of a five-leaved sepaloid perianth, opposite which are five stamens. The female flowers occur in strobiloid spikes. Each flower is very minute, consisting of a cup-shaped perianth, partly surrounding the superior ovary, which contains a single ovule, and is surmounted by two long feathery stigmas, the hop "brush." In this condition hops are said to be "in burr." As the stigmas drop off, whether fertilization takes place or not, there is a rapid growth of the strobile bracts, which produce the hop of commerce. The vines are now said to be "in hop." These strobile bracts contain lupulin glands with a secretion valuable for hop extracts used in yeast brews.

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* Howard, A. *Jour. Agr. Sci.* 1: 1. Jan., 1905.

Whether pollination is necessary or not seems to depend upon the variety used and climatic conditions. German investigators hold that pollination not only is unnecessary but harmful to the satisfactory market value development of the hop fruit. Hops from districts where male plants are not allowed are not seedless, however, showing that efforts for a valuable seedless variety are not as yet successful. In England, where another variety of hop is used and climatic conditions are damper, Kentish growers agree in the opinion that hop crops satisfactory in full and early maturity and in freedom from mould (*Sphaerotheca humuli*) are only obtained when pollination is possible. Mr. Howard's experiments during the summer of 1904 had led to the same conclusion. He found that non-pollinated hops remained undersized, seedless, green, with unripe lupulin glands and little mould-resisting power, while fertilized flowers developed more rapidly, showed well formed seeds, bracts and lupulin glands, a bright yellow color and comparative freedom from moulds. This advantage in mould-resisting power possessed by fertilized flowers is accounted for by the fact that the feathery stigmas, which easily attract mould spores, and afford good germination conditions, wither much more rapidly in fertilized than in non-fertilized specimens. The seed hop, developed by fertilization, therefore, is the only variety known as yet for cultivation in Kent. American growers find that unfertilized hops are light in weight with neither color, strength nor value. Further investigations along the same lines and also as to the brewing value of seed and seedless hops, by determining the total amount of resins in each, are to be pursued, as far as possible during the present year.

M. C. Chedsey.

HOW NEW PLANTS COME IN.

By Dr. W. Whitman Bailey.

There is always great interest attached to the peopling of a new region or the re-habitation of an old. By peopling is not meant here colonization by men or even by animals. By a figure of speech the term is extended to the establishment of plants in a given locality.

Thus, for example, when the island of Krakatoa was destroyed in 1883 by the most stupendous seismic catastrophe in historic time, vegetation was swept away by the flow of lava and the rain of red hot ashes and sulphurous dust. What escaped these destructive agencies met death from the tidal wave, a flood which extinguished whole cities and districts of adjacent lands. Demolition was complete.

It required but a few years, however, to reclothe the island with a fresh growth of plants. It was carefully noted by botanists and others in government employ, what species first arrived, what succumbed to unfavorable conditions upon arrival, and what succeeded in maintaining a foothold and increasing.

It follows that all plants are not equally successful as colonizers, nor is it always evident why certain ones fail while others succeed. The investigation of such problems is of perennial interest. It involves a careful examination of the gross and minute anatomy and adaptive provisions of each species. The study is of direct economic importance as one learns what can best grow in a given place, or what it is folly to attempt.

Without journeying to the antipodes one can see similar action going on near home. The earthquakes of "improvement," the municipal volcano, or the tidal wave of speculation, may involve a piece of land to the utter demolition of its indigenous flora. For a time a desert is left behind, the ultimate abiding place of tin-cans, rusty stove-pipes, demolished baskets, broken bottles, ashes and crockery.

Nature, though banished for a time, does not despair. She first sends an immigrant moss (*Funaria hygrometrica*), to prepare the way for settlers. Later a few winged seeds or fruits lodge on the ground, spring up, flower and spread. By this time the soil is prepared to support more and more plants of higher organization. Soon the hitherto dreary waste becomes a literal flower garden. Here, cheek-by-jowl, may grow the rare exotic and the humble immigrant. Unseemly objects are by degrees obliterated. There results an incessant fight, a guerilla warfare, an advance, a retreat, a victory or a disaster, a time of plenty or a famine, as the so-called " improvement " extends or recedes.

Railroads are active factors in plant introduction by means of which they extend their range and even spread over a city or town.

On the other hand, plants may yield to the ever-changing environment, where filling-in and excavation, a dry or a wet condition, good soil or sterile ashes, alternate from year to year. In consequence we find extreme instability attending vegetable life in such situations. In the midst of a " waste place," where dump-carts deposit the disjecta of the city, there may still exist a swampy spot maintaining the usual lacustrine flora, consisting of cat-tails, arrow-heads, water-plantains, wild-rice, sedges and reed-grasses.

As such a place becomes more and more filled in, the characteristic plants are bound to die. They possess no resources for withstanding semi-burial or even great dryness.

Again we find plants on the arid parts of the waste to which immersion would mean death. The worst thing, however, with which any of them has to contend is the being overwhelmed by material thrown over them.

It is thus a very interesting study to note from year to year what plants have newly arrived, what native ones still remain, and what immigrants succcessfully invade their ground.

THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

We are informed by our President, Professor Charles E. Bessey, of Lincoln, Nebraska, that the ravages due to tourists and visitors in Colorado have become so serious that General William J. Palmer of Colorado Springs, Colorado, has had a lot of warning posters printed and put up on his extensive grounds at "Glen Eyrie."

At the fourth annual meeting of the Society for the Protection of Native Plants an interesting report was presented.

"During the year the number of local secretaries has been increased from forty-three to eighty, and from them have come encouraging reports of increased interest and a large distribution of leaflets.

"In May was issued leaflet No. 10, which is a reprint of a report of the Seal Harbor Village Improvement Society. In June, at the suggestion of a Boston publisher, a small slip was prepared, briefly stating the aims of the Society, to be sent out with nature books. Through the co-operation of publishers in several cities, many thousands of these have reached the purchasers of such books.

"In the autumn a large number of appeals were sent to clergymen, shop-keepers, women's clubs, and to persons likely to give large entertainments, calling their attention to the destruction of the mountain laurel through its excessive use for decoration.

"There have been printed for distribution 71,000 leaflets, 28,000 slips, and 600 cloth posters. These have been sent to hundreds of hotels and boarding-houses, colleges, private and public schools, libraries, women's clubs, secretaries of village improvement and Audubon societies, shops, churches, publishing houses, and to individuals.

"The membership is now: individuals, 909; village improvement societies, 153; other organizations, 273.

	1905	1904
Mailing list	1,335	627
Sustaining members	101	75
Local secretaries	80	43
States represented	32	25
British Provinces, D. C., Korea	7	2

Leaflets of the Society will be sent on application to Miss M. E. Carter, Boston Society of Natural History, Boston, Mass.

The annual meeting of the Society is held during December. Last year we met in conjunction with The American Association for the Advancement of Science at Philadelphia with the cooperation of the Pennsylvania Chapter. This year The American Association for the Advancement of Science is to meet in New Orleans during *Convocation Week* and the Society has received an invitation to meet at the same time, but it has seemed best to decline this invitation and to call the meeting for some place more readily accessible to most of our members. It will probably be held in New York City at the New York Botanical Garden on the twenty-seventh or the twenty-eighth of December.

There are four vacancies in the Board of Managers for 1905 for which the following nominations have received the highest number of votes:

Mr. Stewardson Brown, Philadelphia, Pennsylvania.
Miss Jean Broadhurst, Trenton, New Jersey.
Mr. William T. Davis, New Brighton, New York.
Miss Alice F. Eastwood, San Francisco, California.
Professor F. E. Lloyd, New York, New York.
Mr. E. L. Morris, Washington, D. C.
Mr. Charles C. Plitt, Baltimore, Maryland.
Mr. C. L. Pollard, Springfield, Massachusetts.

Members will please select four names and send their votes to Mrs. N. L. Britton, Secretary, New York Botanical Garden, Bronx Park, N. Y. C., before December 25, 1905.

Correspondence.

EDITOR PLANT WORLD.

Dear Sir:

In attempting to educate the people in the vicinity of Agricultural College, Michigan, to spare wild flowers in woods, swamps, and fields, I have met with scarcely any success. I should be glad if some of your readers who have accomplished anything in this line would make some statement of their work in your magazine, and tell how they do it.

Very truly,

W. J. Beal.

THE TEACHERS DEPARTMENT.

Edited by Professor C. Stuart Gager.

The Biological Relation of Aquatic Plants to the Substratum.

In the biological survey of the Great Lakes, the United States Fish Commission had for one of its problems to ascertain the factors determining the quantity of food fish that the lakes can support. On account of the interrelationships of different forms of life, it became necessary to study, besides the fishes themselves, the plants and other animals of the lakes upon which the fishes either directly or indirectly depend. In the report of the Fish Commission for 1903, under the above caption, Pond gives the results of a series of instructive experiments.

We have different opinions and different experimental data on the question as to whether rooted aquatic plants absorb nourishment throughout their entire surface, the roots serving merely as holdfasts, or whether absorption takes place through the roots accompanied by currents through the tracheae, and an exudation analogous to transpiration.

Among other plants, *Vallisneria spiralis, Ranunculus aquatilis trichophyllus, Elodea canadensis, Myriophyllum spicatum, Potamogetum obtusifolius* and *P. perfoliatus* were studied. The following are some of the author's conclusions:

The roots of these plants are organs of absorption as well as of attachment. There is an upward current in these plants, from roots to stem and leaves. Many of the plants rooting in soil develop root hairs, and the presence of these structures is the rule rather than the exception. *Ceratophyllum* and some other floating plants are able to absorb their nutrient salts directly from the surrounding water. The plants are terrestrial forms adapted to an aquatic habit rather than descendants of plants in which the functions of absorption and excretion are not localized. These rooted aquatics are important contributors to the plankton food supply, because when living they organize matter that may be used as food and in death they yield important salts and organic substances to the water.

In the stocking of ponds for fish culture care should be taken to have a good soil for the bottom; not a stiff clay nor sand, but a good loamy soil, such as is favorable for land plants. The species allowed to grow should be those which are known to possess roots and to be very dependent upon the soil.

THE CAUSE OF DIATOM MOTION.—No physiological phenomenon of cryptogamic plants has been more mysterious, nor given rise to more theories than the motion of diatoms. A new theory has recently been advanced by Jackson.* The motion is not due to cilia, flagella, protoplasmic processes, rhythmical motion of surface film, nor to the endosmotic and exosmotic currents, as other students have suggested.

The "true nature of the motion" was suggested to the writer of the article referred to, by observing the motion of a lithia tablet dissolving in a glass of water. This motion is due to the evolution of bubbles of carbon-dioxid, and when tablets were made of the shape of diatoms their motion was imitated exactly.

Imitation diatoms were then made of aluminium, similar to the plants in shape and surface markings. "When placed in strong caustic soda solution the movements of the metal produced by the evolution of hydrogen gas again duplicated those of the diatom in a remarkable manner."

In the diatom itself the evolution of gas is caused by the photosynthetic activity of the chlorophyll bands in the presence of light. The writer concludes that "the motion of diatoms is caused by the impelling force of the bubbles of oxygen evolved, and that the direction of movement is due to the relatively larger amount of oxygen set free first from the forward and then from the rear half of the organism."

C. S. G.

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*Jackson, D. D. Movements of Diatoms and other Microscopic Plants. Amer. Nat. 39: 287. 1905.

THE USE OF BLUE PRINTS IN LABORATORY NOTES.—Blue prints may be made very useful in reducing the amount of time spent upon note-taking in the laboratory. The apparatus used in experiments may be photographed and then each student in turn may make enough prints from a particular negative to supply the class. In most cases, this takes much less time than it would to draw a diagram of the apparatus used besides being a much better representation of the experiment. The blue prints may be lettered and labeled in the same way as a drawing.

The teacher may find it convenient in some cases to illustrate his lecture by photographing good figures from text-books and making blue prints from these negatives rather than to take time to draw the illustrations as he talks. Blue prints may be made directly from such objects as mosses or leaves by placing them against the sensitive paper in the light.

If one has a dark room, he can easily make his own blue print paper. Mell, in his " Biological Laboratory Methods " gives the following formula:

"BLUE PRINTS:

No. 1.

53.2 grammes citrate of iron and ammonia,........	1⅞ ounces.
236.8 cc. water,....................................	8 "

No. 2.

35.5 grammes ferricyanid of potassium,............	1¼ ounces.
236.8 cc. water,....................................	8 "

Mix the equal parts of No. 1 and No. 2, and float the paper on the solution for three minutes. Plain Rives paper should be used. Hang up to dry in dark room. (International Annual, 1902.)"

W. J. R.

REVIEWS.

The Structure and Development of Mosses and Ferns. By DOUGLAS HOUGHTON CAMPBELL. Pp. vi + 657. $4.50. New York: The Macmillan Co. 1905.

This is a second edition of the author's book bearing this title, though the fact is not indicated on the back of the cover, on the title page, nor by a reprint of the preface to the first edition. The genuine regret felt when it became known that the first edition was exhausted is surpassed by the pleasure with which the second edition is being received. Parts of the work have been entirely recast to bring it abreast of the most recent researches, and two new chapters have been added on "The Geological History of the Archegoniates," and on "The Nature of the Alternation of Generations."

In the latter chapter the author inclines to the antithetic theory of the origin of the leafy sporophyte, *i. e.,* that the leafy sporophyte arose "from the zygote of some aquatic algal ancestor," rather than to the homologous theory, that the sporophyte arose as a modification of the gametophyte.

Several new cuts enhance the value of the illustrations, and the bibliography has been entirely revised and increased. The usual high order of typographical work of the publishers is maintained throughout.

C. S. G.

Research Methods in Ecology. By FREDERIC EDWARD CLEMENTS, Associate Professor of Plant Physiology in the University of Nebraska. Lincoln, Neb., The University Publishing Co., 1905.

This is the first serious attempt in this country at a systematic presentation of the problems of plant ecology. The volume is not a text-book, but a hand-book for advanced students and investigators, and is an outcome of the author's eight years of research. The point of view is that ecology is "the dominant theme in the study of plants, . . . the central and vital part of botany." The author sanely identifies physiology and ecology, and emphasises the fact that both have suffered through their divorce at the hands of extreme specialists.

The first chapter on the needs and essentials of a system, is followed by Chapter II. on the "Habitat," the construction and use of instruments, and methods of habitat investigation. Chapter III. is devoted to the plant, with the subtitles, "Stimulus and Response," and "Experimental Evolution." The last chapter discusses in detail "Formation and Experimental Vegetation." A glossary and bibliography complete the work.

The book will not only help to bring order out of chaos, but will render a needed service in placing ecological work on a quantative basis. Students and teachers will await with interest the author's elementary textbook on the subject, announced in the preface of the present volume.

C. S. G.

Volume 8 Number 12

The Plant World

A Magazine of Popular Botany

DECEMBER, 1905

WILHELM HOFMEISTER.*

(WITH PORTRAIT.)

BY PROFESSOR K. GOEBEL,
University of Munich.

Among the men who, in the nineteenth century, laid the foundations of the botany of to-day, Wilhelm Hofmeister is not only the most prominent, but, through his whole life long, was the most phenomenal. In contrast to other countries, as for example England, scientific activity is in Germany almost always confined to, or at least stands in close relation to, the University. Hofmeister, however, never studied at a University, and he did not even have the " classical education " of the gymnasium. He carried on his most important researches while he was a bookdealer, and as he himself told me, the only time he had in which to prosecute the epoch-making studies embodied in his " Vergleichenden Untersuchungen " was between the hours of four and six in the morning in summer. Even thus, he did more qualitatively and quantitatively than any of his contemporaries although he lived but fifty-three years, and his end was overshadowed by heavy misfortune. Let us now look at the leading facts of this remarkable life.

Hofmeister was born on the eighteenth of May, 1824, in Leipzig, where his father carried on his business as a commission bookdealer. From his father, who was also a student of systematic botany, the son inherited a love for the natural sciences. But no one thought he would take up science as a life work.

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* Authorized translation by F. E. Lloyd.

After his attendance at the *realschule* he addressed himself to the calling of a publisher and later entered the business of his father. At the same time he busied himself with botany. That Schleiden's "Elements of the Science of Botany," which appeared in the year 1842, with its suggestive though often crude and not seldom unjust criticism of the older trend of botanical thought, and with its stimulating indication of the significance of the developmental method, influenced him we already know from the other great botanists whose youth was of the same period; thus Sachs has said that Schleiden's book, though it contained many errors, was as the ruddy dawn of a new day to come. Entirely self-taught, Hofmeister started, at about the middle of the last century when but nineteen years old, upon a series of highly significant studies, studies which placed him at once in the first rank of botanists. To these I shall refer below. Although his results were to some extent called into question, Hofmeister's works gained for him recognition from the best of his contemporaries. In 1851 he was adorned with the Doctor's degree, *honoris causa,* by the University of Rostock—one of the smallest of German universities to be sure—and was thus initiated in a sort of way into the academic guild. In the year 1863 he was called to the Ordinary Professorship of Botany and the Directorship of the Botanical Garden of the University of Heidelberg. That a man in private life, though learned, who was not a Docent in the University, should be made Ordinary Professor is an unheard of thing in Germany, aside from the Faculties of Medicine. Moreover, Hofmeister's call came not on the nomination of the Faculty, but directly from the Ministry who quite rightly represented him "as one of the first botanists of Germany, as a man of distinguished gifts, of great energy and application and of remarkable powers of presentation."* We are under the greater obligations to the Ministry for this act, since as a result not only was Hofmeister's scientific activity greatly increased—the writing of his general morphology would scarcely have been possible had he not been able to give his

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* See "Wilhelm Hofmeister," by E. Pfitzer, in "Heidelberger Professoren aus dem 19 Jahrhunderts." Festschrift der Universität zur Centenarfeier — Erneuerung durch Karl Friedrich. 2 Bd., 1903.

WILHELM HOFMEISTER.

time entirely to his scientific work—but otherwise he would have been prevented from leading students into science.

The immediate transfer of Hofmeister from the book shop to the lecture room was justified to this extent, at least, that he entirely overestimated the comprehension and interest of the majority of his hearers who consisted for the most part of students of medicine, pharmacy and natural science—the latter in very small numbers. He went into his subject very thoroughly basing it chiefly on the conclusions of his own study. After the first lecture the benches of the auditorium were nearly empty, and of 80 to 100 attendants in Tübingen, whence Hofmeister was called in 1872 to succeed H. Mohl, and of whom the author of these lines was, from 1873 to 1876, a pupil, hardly a dozen remained. These however had a rich opportunity for study, for it was a pleasure to listen to a man who could draw upon the fulness of his knowledge, who from first to last trod his own path, and who did not allow himself to be dependent upon the representations of the text-books. And, too, his demonstrations of microscopical preparations were always instructive and in great profusion, a thing for that time quite new. In his "microscopical practicum" we could not but admire his mastery in making preparations which was nothing less than marvelous. It will be recalled that at that time there were in use neither microtomes nor hardening or staining agents, and only occasionally were alcoholic materials used. But Hofmeister was able, by holding an ovule so small as to be scarcely visible to the naked eye between the thumb and forefinger, so to cut it that the embryo-sac could be clearly shown. In this, his marked shortsightedness was of use to him, while it did not hinder him in the least in out-of-doors work in finding research materials of small plants such as the liverworts. He had a fine instinct for plant habitats, and would throw himself flat on the ground in a place where he expected to find some desired plant, as *e. g.*, an Anthoceros, and he would usually soon find it.

His appearance had in it nothing of the Germanic type; he looked, as Pfitzer has rightly said, like a southern Frenchman. Of small supple form, he possessed a dark, clear-cut, and uncommonly vivacious face; he was always bubbling over with activity and ever showed great kindness toward his pupils.

When I became acquainted with him in 1873 he had, of course, passed the zenith of his power. Aside from the almost superhuman amount of work which he had done during the previous thirty years, it was the severe misfortune which overtook his family which broke him down. In the course of a few years he lost his wife and two matured sons from tuberculosis. He himself in May, 1876, survived a stroke of apoplexy which compelled him to resign his office, and to remove to Leipzig where he died on the twelfth of January, 1877.

I will now endeavor, with all brevity, to point out the significance of his scientific activity. The best known of all is Hofmeister's brilliant contribution which demonstrated the homologies which exist between the Phanerogamae and the Cryptogamae. At the middle of the last century botanists considered these two groups as widely separated divisions of the plant kingdom, and had as yet no idea of the relationship between mosses and ferns, Pteridophyta and Gymnospermae. Indeed long after Hofmeister's views had become known, the English systematists still placed the Gymnospermae close to the Dicotyledonae. It was reserved for Hofmeister, in his "*Vergleichende Untersuchungen*" (1851) to develop the proof that there occurs an alternation of generations in all the Archegoniatae, that the sporogonium of the mosses is the homologue of the fern plant proper, that the reproduction of the Gymnospermae and the Angiospermae relates itself immediately with that of the heterosporous Pteridophyta, and that in the former the alternation of generations is masked by the formation of the seed.

This is, in very truth, the greatest discovery that has ever been made in the realm of plant morphology and taxonomy. It was expressed by Hofmeister in short every-day words without the introduction of new terms, quite in contrast with the long-drawn-out fashion with which many botanists now-a-days bore their readers. How penetrating Hofmeister's thought was is shown by the fact that he held it as not only possible but probable, that sperm cells would be found to occur in the Gymnospermae, and this as is well known, has been recently shown to be the case in Gingko and the Cycads. An uncommonly large number of particular studies are included in the same work. Many of these have been extended and corrected by later research, but the main results have nevertheless remained as the strongest pillars of our knowledge of the interrelations of the chief divisions of the plant kingdom.

A second important contribution of Hofmeister's was his demonstration that in the Angiospermae, the embryo develops from the egg cell which is present in the ovule before fertilization and which had previously rarely been seen, by Amici and some others. This general truth which appears to us almost axiomatic, was denied by Schleiden and his followers, including Schacht, who maintained that the embryo developed from the end of the pollen-tube, after it had penetrated into the ovule. The contention lasted for years, but ended in complete victory for Hofmeister, who by his studies taught us the manifold form and development of the ovule. In this, also, time has contributed many further details and corrected many conclusions which resulted from an undeveloped technique, but it has not added anything new in principle to the results of Hofmeister.

Important in an especial degree has his last morphological work the "*General Morphology of Plants*" become, although the trend of research indicated in it is as yet but little recognized in botany. It may, however, with certainty be prophesied that this trend will be represented in the morphology of the future. The time was when morphology was first descriptive and then comparative, but this is now passed. It has now come to be *causal i. e.,* the study of the dependence of the plant organization upon inner and outer conditions. This trend was first indicated with emphasis by Hofmeister in the above mentioned work, long before the "Entwickelungs-mechanic" arose in zoology. In this he presented a strong contrast to the conceptions prevalent in his time, which took the form of the idealistic morphology. This morphology regarded the general concepts derived by us through our perceptions as something concrete, and conceived particular forms as the realization of abstract ideas, and so entertained no thought nor felt the need of causal interpretation.

It is clear that he who undertook so severe a task should have to depend rather upon explanations and general propositions than upon a sure solution which is to be had only through experimentation. But a beginning had to be made, and for it we must thank Hofmeister's book. Its influence is somewhat limited in that it is difficult to read. Facts and conclusions are crowded together in the highest degree, and it is not lacking in errors of presentation which make the understanding of it difficult. But the "*General Morphology*" is nevertheless a powerful piece of work. And I may perhaps be allowed to add that it was the first botanical book which I bought as a young student, and that, in spite of the difficulty of understanding it, it made an impression on my mind which has lasted my whole life. It should also be noted that Hofmeister pointed out the importance of what we now call "mutation" and was suggestive in many other ways.

In his "Allgemeine Morphologie" (p. 564) he says, "One of the most striking and remarkable facts in the variation of plants without any doubt is the suddenness of wide-reaching differences from the usual conformation. . . . The new form arises not by summation of small aberrations from the normal courses of development all pointing in the same direction; it appears at once, complete in its wide divergence from the parental form."

In particular by this book and by his "Zelllehre" he set botany free from the narrow confines which threatened to stifle it. Under the influence of Nägeli the view had sprung up that the most important thing for morphology is the arrangement of cells in young plant parts, and that the whole of growth is conditioned by the manner in which cells divide and are arranged. Hofmeister, however, for the first time conceived the embryonic plant part as a whole in itself, and cell division in the particular cells as something secondary, and thus paved the way for Sach's well known studies on cell arrangement and growth. The doctrine of the cell owes much in other ways to Hofmeister, although I cannot here go further into details. It may, however, be pointed out that Hofmeister was active also as a physiologist. He carried out important research on "bleeding" and upon the movement of water in plants, and supplied the basis for our knowledge of tissue-tensions. He was less happy in his theory of the *responses* of plants which, after the fashion of his time, he tried to explain in a crass, mechanical way. But the few mistakes of the great student are hardly worth consideration in view of the mass of his work which has remained unchanged by time. If one reviews the sum total of the work of his life, and the significance of its results, one is forced to clearly recognize that Hofmeister was not merely an active and industrious man of learning, such as botany has often possessed, but a real genius, such as appear in a science only between long intervals of time.

NOTES ON THE FERNS OF NORTH-CENTRAL ONTARIO.

By A. B. Klugh,
Ontario Agricultural College.

The last two days of July and the month of August, 1905, I spent awheel touring the Bruce Peninsula and the northwestern portion of Grey County, Ont., with a view to ascertaining the fern-flora of that region. The rock-formation of this area is limestone, outcrops of which occur with great frequency, and it is on these outcrops that we find the characteristic ferns of the region.

That there are many more species to be found and many other stations for rare species to be discovered goes without saying, as every botanist knows how often plants exist in a well-worked area for years without discovery and especially is this the case in such country as that through which I travelled, where much difficult climbing is entailed.

One of the ferns which render this region particularly interesting is the hart's tongue (*Scolopendrium vulgare*). At many places throughout the area it is abundant, always growing in woods at the top, or on the slopes, of limestone ridges. For a detailed account of this species as it occurs here I would refer the reader to my notes in the *Fern Bulletin,* October, 1905, and here I wish to deal more particularly with the other species found.

The holly fern (*Polystichum lonchitis*) might perhaps be termed the characteristic fern of this territory. Beside occurring wherever the hart's tongue does it is also found in some places where the latter is absent. In many places it was present in great abundance, always growing in shade in crevices (usually at the top, but often some three feet down) in limestone ridges or in hollows in limestone boulders. It is a most beautiful species, combining as it does a delicacy of outline with a firmness of frond. Some fronds reached a length of twenty inches, but the average length was ten inches.

The prothallia are found principally some distance down crevices where the air is moist. The first fronds are two-lobed, from two to three lines long and very thin and membranaceous. Between this infantile stage and the adult form of frond are to be found fronds with two or three rather large (for the size of the plant) pinnae with blunt-crenate margins, then fronds which resemble the green spleenwort (*Asplenium viride*) in texture and form, after which stage they become spinulose-toothed and begin to assume the firm texture of the fronds of the adult plant. The spinulose teeth begin to show in some fronds when one and one-quarter inches in length, while others one and three-quarter inches long still resemble the green spleenwort. The leathery texture becomes manifest in fronds about two inches long and when the plants bear fronds three and one-half inches long some of them begin to bear fruit-dots.

While there is some variation in the cutting of the adult fronds I only found one frond, and that a small one, in which the cutting was widely different from type. In this case the spiny teeth on each pinna were very few (only four to ten to the pinna) and the pinnae from just below the middle of the frond were cleft very irregularly and nearly to the midrib.

Another fern of this reigon is interesting because its only station, besides a small station at Niagara Falls, is in the north-central part of the province. This is the Male Fern (*Nephrodium filix-mas*). The first station reported in Canada was Owen Sound. While I did not see it in the vicinity of Owen Sound, I found it on McLean's Mountain near Kemble, thirteen miles north of Owen Sound. Here it was growing near the base of a rocky wooded slope, but was decidedly scarce, as I could only find one plant which bore fertile fronds and not a great number of other plants.

At Cape Croker, on the east shore of the Bruce Peninsula, on the wooded precipitous side of a high limestone ridge, I found it to be fairly common in a limited area. Here fertile plants were almost as common as those which bore only sterile fronds.

On the slope of McLean's Mountain the hart's tongue (*Scolopendrium vulgare*), holly fern (*Polystichum lonchitis*), spinulose shield fern (*Nephrodium spinulosum*), marginal shield fern (*N. marginale*), maiden-hair fern (*Adiantum pedatum*), bulb-bearing bladder fern (*Cystopteris bulbifera*) common bladder fern (*C. fragilis*), maiden-hair spleenwort (*Asplenium trichomanes*) and walking-fern (*Camptosorus rhizophyllus*) were common, the latter being present in such quantity as to form dense mats over many of the limestone boulders.

At Indian Falls, near Owen Sound, I found Goldie's shield fern (*Nephrodium Goldieanum*) to be fairly common down in the gorge. This is the only place where I saw this species in north-central Ontario and it appears to be its northwestern limit in Canada. Here also I found the only plant of the Christmas fern (*Polystichum acrostichoides*) seen in the region. Taking North Grey County as a whole the following is the abundance of the various species seen during my tour: *Botrychium virginianum,* common; *Polypodium vulgare,* scarce; *Adiatum pedatum,* common; *Pteris aquilina,* common; *Asplenium trichomanes,* common; *Athyrium filix-foemina,* common; *Scolopendrium vulgare,* common; *Camptosorus rhizophyllus,* common; *Phegopteris dryopteris,* scarce; *Nephrodium thelypteris,* common; *Nephrodium filix-mas,* rare; *Nephrodium goldieanum,* scarce; *Nephrodium marginale,* abundant; *Nephrodium cristatum,* scarce; *Nephrodium spinulosum,* common; *Polystichum acrostichoides,* rare; *Polystichum lonchitis,* common; *Cystopteris bulbifera,* abundant; *Cystopteris fragilis,* abundant; *Onoclea sensibilis,* common; *Struthiopteris germanica,* frequent.

At three places in Bruce County—Colpoys Bay, Flower Pot

Island and Cape Croker—I found the slender cliff brake (*Pellaea gracilis*) and in a sandy marsh at Oliphant, on the shore of Lake Huron, I found the marsh horsetail (*Equisetum palustre*) to be common and the low selaginella (*S. spinosa*) frequent. Both had scattered their spores.

August 26 I spent on Flower Pot Island at the head of the Bruce Peninsula, a very rough and rocky island about two miles in diameter, inhabited chiefly by a light-house keeper and wildcats, and of interest to botanists principally because it is the only known station for the wall rue (*Asplenium ruta-muraria*) in Ontario. I found this fern to be rare, and growing in moss on the sides of rather dry limestone boulders.

Among rock-fragments on the shore there grew a small patch of the variegated horsetail (*Equisetum variegatum*).

Flower Pot Island was the only place in north-central Ontario where I saw the green spleenwort (*Asplenium viride*) or the purple-stemmed cliff-brake (*Pellaea atropurpurea*), though these limestone-loving species must exist in many places throughout the region.

Other ferns noted on Flower Pot Island and their abundance are: *Polypodium vulgare,* frequent; *Pteris aquilina,* frequent; *Asplenium trichomanes,* common; *Nephrodium marginale,* scarce; *Nephrodium spinulosum,* scarce; *Polystichum lonchitis,* scarce; *Cystopteris bulbifera,* scarce, and *Cystopteris fragilis,* common.

A PECULIAR HYGROSCOPIC MOVEMENT IN THE CAPSULES OF KNEIFFIA.

By Roland M. Harper.

On the afternoon of August 10, 1905, as I was walking along the edge of a brackish marsh about a mile east of Freeport, Long Island, my attention was attracted by some specimens of the evening primrose, *Kneiffia linearis* (Mx.) Spach (*Oenothera lineris* Mx.), nearly past flowering, bearing numerous ripe capsules all of which were wide open at the apex. The tips of the four valves of each capsule diverged at a considerable angle, giving the whole capsule much the aspect of a campanulate corolla. These capsules are clavate when closed, as is well known, and the separation between the valves extended about a third of the way down, or just to the widest part.

Never having noticed such spreading valves in this genus before, my first thought was that I had perhaps discovered a new species. It was raining gently at the time, and had been for about two hours, but I did not connect this fact with the unfamiliar appearance of the plant until the next morning, when I found the capsules all closed on some specimens I brought home. On experimenting then I found that they would soon open when immersed in water, and close again when dry. The valves seemed just as rigid in one condition as in the other.

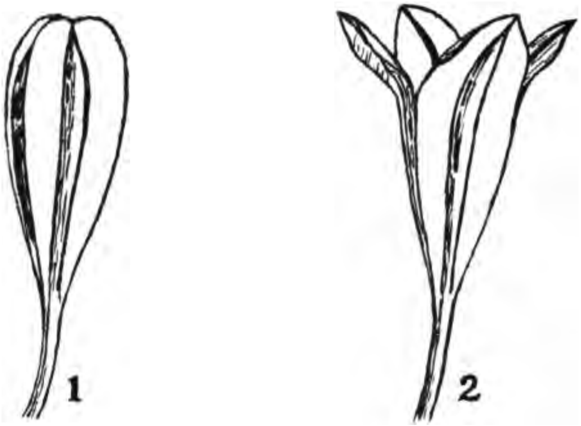

FIG. 59. 1. Pod of Kneiffiia closed; 2. open.

This hygroscopic movement is obviously connected with dissemination, but just how it is an advantage to the plant to have its capsules open only in wet weather is not clear. Most plants with dry fruits which are known to have hygroscopic movements act just the reverse of this, discharging their seeds in dry weather. The exact manner in which the seeds of *Kneiffia* escape does not seem to have been determined, but these problems could doubtless be solved by a little careful observation in the field. Most plants with erect capsules borne on stiff erect stems scatter their seeds by means of the resilience of the stem when it is agitated by the wind or a passing animal,* but this is probably not the case with *Kneiffia.*

In the limited time and space in which my observations were made I could not be sure that the *Kneiffia* was really indigenous where I found it, but like most of our other eastern Onagraceae it is distinctly a sun-loving plant (in Georgia preferring dry pine-barrens), and possibly if its seeds escaped in dry weather they would be injured by the sun's heat before they could germinate.

Kneiffia was for a long time united with *Oenothera* by systematists, but the behavior of the capsule now furnishes an additional character for separating the two genera. In *Oenothera,* at least in the commonest species, *O. biennis,* the valves of the capsule split apart about half their length at maturity, and remain so permanently.

THE DEFENSES OF THE COCK-SPUR THORN: ANOTHER INTERPRETATION.

By Willard N. Clute.

The time was when I used to think as Dr. Leavitt does, that the thorns of the hawthorns are mainly or solely for defense, but after looking further into the matter I am not so sure. I notice that at the very time when thorns would be most useful these objects on the young and tender shoots are likely to be young and tender too, and not particularly obnoxious to the cow or other grazing animal. Then again, if a thorn tree knows enough to set its thorns in just the right position to puncture the cow's tongue to the best advantage, surely it ought to know that no cow can nip the leaders on shoots fifteen feet from the ground and yet the plant goes on producing thorns just the same.

If you will go into the nearest pasture set with hawthorn, you may have abundant evidence to show that cows do not refrain from eating the hawthorns, thorns or no thorns. Quite on the contrary, they apparently consider them good forage for every little starveling shrub is kept sheared of its tender twigs throughout the summer. The only way in which the shrub can outwit its enemy is to continue to put out side shoots from year to year, letting the cows nip the young and tender tips but making what is left stout and woody until it has formed a bush so wide that no cow can reach the center from any side. Then the shoots in the center may carry the shrub upward, and this they immediately do. Every thorny pasture is full of these bushy shrublets biding their time.

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* Dr. Clements has given the name of "tonoboles" to plants having this mode of dissemination. (Bot. Surv. Neb. 7: 47. 1904; Research Methods in Ecology, 217. 1905.)

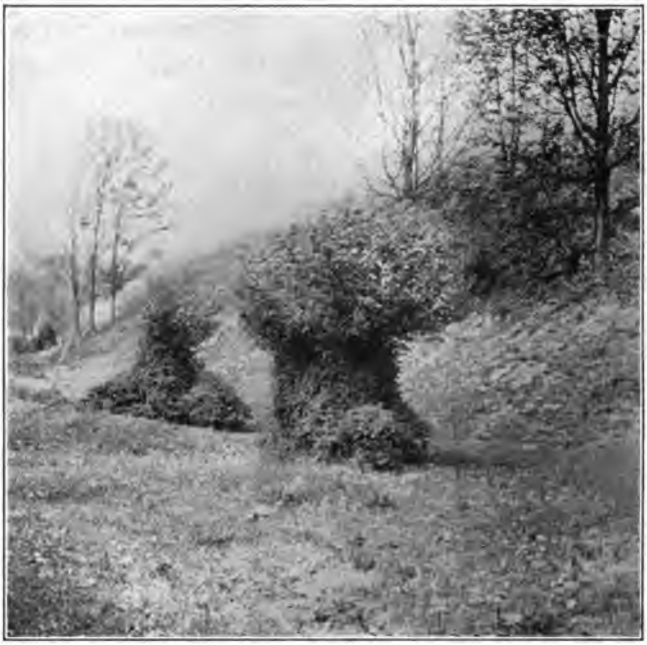

FIG. 60. Pasture with Cock-spur Thorns trimmed by cattle.

After the shrub has got beyond the stage where the cows can no longer keep its leaders down, the cows continue regularly to trim up the side branches until the pastures look much as if ornamented by the topiary artist. The accompanying illustration is from a photograph of two plants that have been thus shaped and which to my mind show very plainly that thorns do not always protect.

We are, I believe, to look for the cause of thorns in these plants to some inherent quality of the plants themselves. There are certain families of plants that run to thorniness and several of these are centered around the rose family. There are many thorny species among the legumes and in the rose family, to which the hawthorn is most closely related, *e. g.*, blackberries, raspberries, roses and others. It seems to me the reason why these plants produce thorns and prickles is because "it is their nature to."

THE TEACHERS DEPARTMENT.

EDITED BY PROFESSOR C. STUART GAGER.

The Following Notice has been received from the U. S. Department of Agriculture, under date of November 25, 1905:

The fiber exhibit of the U. S. Department of Agriculture at the Louisiana Purchase Exposition consisted in part of commercial bales of plant fibers such as are used in the manufacture of yarn, thread, twine, cordage and woven goods. These bales have now been broken up into samples, with labels stating origin, preparation, and use, and are being distributed to schools and colleges for use in teaching economic botany and commerical geography. Sets will be furnished for school use upon application to the Office of Fiber Investigations, U. S. Department of Agriculture, Washington, D. C.

ANOTHER ROOT CAGE.—A simple and effective root cage may be made from a wide lamp chimney. Get the largest size, and invert it in a dish: fill with earth (or sand) to the widest part, and then plant the seeds near the edge. On account of the sloping sides the roots will run down in contact with the glass. Such a root cage costs only ten cents and is as good as any that I have used.

CHARLES E. BESSEY.

DEMONSTRATION OF MASKED CHLOROPHYLL IN FROND OF LAMINARIA.—If a frond of *Laminaria* of desired length, after being simply air dried, be passed with moderate rapidity through a Bunsen flame, at once the brown coloring matter (phycophaein) disappears, the discharge of a misty vapor accompanying the change.

By placing a coin heated to a proper temperature, on the frond, and exerting pressure, a green impression can be immediately produced. Metal stamps of various designs act similarly. To obtain printed impressions the letters require to stand out well.

By playing a lens upon the frond for a short time, green spots or lines may be produced, accompanied by a beautiful demonstration of the misty vapor making its escape. The changes thus produced are of course due to the vaporization of the brown coloring matter, thus leaving the chlorophyll unmasked. (Thomas Berwick. Proc. Bot. Soc. Edin. **22**: 395. Jy. 1905.)

" . . . the leaves of the unifoliate species of *Streptocarpus, e. g. S. Wendlandi,* are superior objects for the demonstration of water-absorption by the leaf surface. If a wilted leaf is plunged under the surface of water, it will be quite quickly restored to a condition of turgidity." (K. Goebel in Flora, **93**: 542. 1904.)

A SIMPLE MODIFICATION of Detmer's experiment to demonstrate the need of light for photosynthesis is given by King in *Torreya* for April, 1905. Miss Haug (*Bot. Gaz.,* November, 1903) has called attention to a source of error in the experiments as described by Detmer, in which two pieces of cork are pinned opposite to each other on the two surfaces of the leaf. By this arrangement there is a possible exclusion of carbon-dioxide as well as of sunlight. The modification proposed by King is to substitute for the corks " narrow strips of black cloth about as coarse-meshed as cheese-cloth." By this means the carbon-dioxide finds ready access to the tissue by diffusion through the cloth, while light is effectually excluded. No starch is formed under the strips of cloth. C. S. G.

REVIEWS.

Bacteria in Relation to Plant Diseases. By ERWIN F. SMITH. Volume I. Publication Number 27 of the Carnegie Institution of Washington, September, 1905.

The science of plant pathology is not old, and the knowledge of the relation of bacteria to the diseases of plants is the youngest part of this science. Less than ten years ago, the bacterial origin of disease in plants was very much doubted or denied outright. The view that bacteria may enter the plant and be the active agent in the production of pathological conditions is now generally established and this is due in no small measure to the careful and painstaking work of the foremost American student of phytopathological bacteriology, Dr. Erwin F. Smith. It is very fitting that Dr. Smith should undertake to write an elaborate treatise upon the matter with which he is so familiar and in which he has been so active, and the first volume of this work is to hand. This deals with the methods of operation in the study of bacterial disease in plants, and includes also a very exhaustive bibliography. It will be readily understood that there is a good deal of compilation, but this is of a critical and exhaustive kind which in this day of vastness of literature is of very great importance to other students in the same field.

The second volume, which is to appear, will no doubt be descriptive of the diseases themselves, and this will naturally be the more interesting to the general botanist. There can be no doubt that this work of Dr. Smith's will lay the foundations for thorough-going study of the subject of which he is so able a master.

Botanical science is to be congratulated that through the unstinting editorship of the Carnegie Institution such a memoir as the above may be published in a worthy manner. Aside from the beautiful typography is to be noted that the paper used is of a very excellent quality which makes the printing of half-tones possible without the use of the usual clay-laden paper of the evanescent magazine. The zeal which has led to this end is much to be appreciated and commended. L.

The New Knowledge. By ROBERT KENNEDY DUNCAN. 8vo. Pp. xviii + 263. New York: A. S. Barnes & Co. 1905. $2.00 net.

While this book is "A popular account of the new physics and the new chemistry in their relation to the new theory of matter," we review it here because we believe every teacher of botany, as of every other science, ought to be familiar with its contents. The boundary line between biology and chemistry grows fainter and fainter in the light of the more recent researches, and as a result of these investigations our conception, not only of non-living matter, but of matter in the living state as well, must be profoundly modified.

The facts presented in this volume will soon be, if indeed they are not already, fundamental to any intelligent conception of plants and of all life processes. The statements of fact are clear and accurate, the style unusually forceful and interesting, and the effect of reading it is a mental stimulus. The titles of the seven Parts are as follows: Current conceptions; The periodic law; Gaseous ions; Natural radio-activity, a new property of matter; The resolution of the atom; Inorganic evolution; The new knowledge and the old problems. Over 54 cuts illustrate the text.

C. S. G.

Minnesota Plant Diseases. By. E. M. FREEMAN. State Publication, St. Paul, Minn. 8vo. Pp. xxiii + 432. 1905.

In the August, 1905, PLANT WORLD we published an article by Professor C. E. Bessey entitled, "How Much Plant Pathology Ought a Teacher of Botany to Know?" At that time there was no one publication of recent date presenting in non-technical language the essential facts of plant diseases. All teachers who feel the need of such knowledge as Professor Bessey outlined will find Dr. Freeman's book a most welcome volume. The edition is uniform with *Minnesota Plant Life,* and, like the latter, is as interesting and instructive as it is authoritative. Throughout the work there is carried out the author's high ideal not to offer a receipt book, but "to disseminate knowledge of the destructive parasites of the useful plants of this state, to assist all concerned in the cultivation of plants to a more intelligent and thorough understanding of the habits of these parasites, and to point out established methods of combating such diseases." The aim is "rather *educational* than *immediately practical.*" The book is a model of what such state publications ought to be.

C. S. G.

The Fern Allies of North America North of Mexico. By WILLARD NELSON CLUTE. 8vo. Pp. xiv + 278. Illustrated. New York: Frederick A. Stokes Co. 1905. $2.00 net.

The best feature of this work is the author's attempt to make it an out-of-doors book, by emphasizing life-histories and giving many suggestions for further field observations. For those who have patience to use it, the numerous illustrations, though no more satisfactory than those of the author's fern book, may be of considerable help in learning to identify the species. The scope of the book ought to furnish a broader idea of the groups treated than the manuals of more restricted range, and the collection of illustrated accounts of many rather recently described forms will be a convenience. But why, to be popular, must a book be unsystematic in arrangement and description, diffuse in style, and unscientific in statement? From a considerable experience with nature lovers, the reviewer believes that beginners would distinguish species far more easily by means of briefer, even semi-technical descriptions, such as appear in two or three popular guides to trees and ferns, than by reading through five or six pages to learn the characters of, for example, the field horsetail. Many will uphold the author's position that it is preferable to employ names in common use, but it would be difficult to imagine anything more confusing to the "novice" for whom the author expresses such frequent concern, than his constant and controversial nomenclatural digressions. Nor is his employment of a method of citation which is entirely unfamiliar to botanical usage, consistent or justifiable in such a book, even though it be admitted that "the author of a new combination is not entitled to the prominence which a double citation of authorities confers." Not less confusing to the beginner will be some of the morphological inconsistencies, *e. g.*, the statement that "In our species of Lycopodium there is nothing that can be called a rootstock, unless we are inclined to call the main axis a combination of rootstock and stem" followed by the line in the specific key, "Fertile and sterile stems erect; rootstock creeping." The author had the opportunity to produce a book which would supply a real want among untrained fern students, but it must be said that his inability to lay aside his controversial spirit is chiefly responsible that the result is not more successful. T. E. HAZEN.

Methods in Plant Histology. By C. J. CHAMBERLAIN. Second Edition. 8vo. Pp. 10 + 262, illustrated. $2.25 net. Chicago, Ills. University of Chicago Press.

Dr. Chamberlain's useful guide to microscopic work with plants is already known to many teachers and students of botany and its value is acknowledged. The second edition, appearing four years after the first, is much richer, including as it does directions for collecting and for growing laboratory materials. A full account of the new Venetian turpentine method is also given. The book ought without doubt to be in the possession of every botanical laboratory, and it will be indispensable to every worker in plant histology. L.

A Nature Study of Maryland Plants is the title of Volume 2, Number 1, of the Maryland Agricultural College Bulletin, April–June, 1905, by Frederick H. Blodgett. This is a pamphlet of 22 pages, richly illustrated with numerous half-tones, which will be helpful to the teacher in guiding her by suggesting what one may expect to find and what to look for during the days of spring.

INDEX TO VOLUME VIII

Allium, Daily Periodicity in the Root of, 183
Andrews' Botany All the Year Round, [Review of], 110
Anthers of the Compositae, 131
Anti-Ferment Reaction in Plants, 156
Arthur, J. C., 71, 99
Atkinson, George F., 215, 245
Atkinson's College Text-Book of Botany, [Review of], 187
Aquatic Plants, Biological relation of, to the Substratum, 287
Bailey, Wm. Whitman, 104, 283
Balfour, Isaac Bayley, 1
Beal, W. J., 121
Bean Seedling, An Anomalous Structure on the Leaf of a, 22
Begonia, An Unusual, 12
Bergen's Elements of Botany; Note-Book to Accompany, Text-Book of Botany, [Review of], 110
Bessey, Charles E., 39, 189
Blodgett, Frederick H., 170, 309
Blue Prints, Use of, in the Laboratory, 289
Brackett, Mary M., 6, 29, 265
British Columbia, Botanizing in, 105
Britton, Mrs. N. L., 14, 79
Broadhurst, Jean, 255
Buds, Protection of Winter, 44; Biology of, and Twigs in Winter, 78
Burro Thorn, The Chimney-shaped Stomata of the, 126
Cactus as a Forage Plant, 150
Campbell's Structure and Development of the Mosses and Ferns, [Review of], 289
Catskills, The Plant Formations of the, 276
Chamberlain's Methods in Plant Histology, [Review of], 309
Chedsey, M. C., 281
Chickweed, Winter Shoots of, 82
Chlorophyll, Demonstration of Masked, 305
Cleistogamous Flowers and the Theory of Adaptation, 177
Clement's Research Methods in Ecology, 290
Clute, W. N., 303
Clute's Fern Allies of North America, [Review of], 308
Cock-spur Thorn, The Defenses of the, 239, 303
Comstock's My Own Book of Three Flowers which Blossom in April, [Review of], 264
Cork Columns on the Sweet Gum, 133
Corn, The Barley, I. Some Points of Structure, 223; Raising, in the Laboratory, 260
Courses, Summer, in Botany, 137
Crawford, Joseph, 49
Culture, Plant, Outline of a Course in, 234
Detmer's Photosynthesis Experiment, Modification of, 158
De Vries' Species and Varieties: their Origin by Mutation, [Review of], 86, 110, 135, 150
Diatoms, Cause of Motion, 288
Drought, Physiological, in Relation to Gardening, 1
Duncan's The New Knowledge, [Review of], 307
Ecological Work in Botany, A Brief History of, 163, 198
Experimental Work in Schools, 255
Fasciation in the Cherry, 35; in Field Peas, 170; Its Meaning and Origin, 183
Ferns of North-Central Ontario, 298
Fibers, Samples of, for distribution, 305
Flora, The Earliest Local, 115
Flower Show, The Spring, at the Orchard Street School, 152
Freeman's Minnesota Plant Diseases, [Review of], 308
Fungi, Nomenclature of, having many Fruit Forms, 71, 99; Outlines for the Observation of Some of the More Common, 215, 245
Gary, Lester B., 257
Gas Plant, The, 121
Geography, Botanical, for Schools, 81
Geotropic Shoots, Demonstration of Positively, 43
Goebel, K., 43, 291, 306
Goebel's Organography of Plants, [Review of], 263
Goodrich's First Book of Farming [Review of], 186
Grape Vine, Effect of Winds on the Leaves of the, 132

Greene, Edward L., 115
Grout's Mosses with a Hand Lens, [Review of], 110
Harper, Roland M., 301
Harshberger, John W., 276
Hofmeister, Wilhelm, 291
Hop, Influence of Pollination on Development of, 281
Inaguas, A Trip to the, 63, 91
Intoxicating Plants, Catching Fish with, 262
Iowa, Plants of Northeastern, 31
Java; A Botanist's Trip to, 139
Journal of Agricultural Science, [Review of], 213
Kagan, Fannie, 20
Kinney, Asa, 234
Klugh, A. B., 298
Kneiffia, Hygroscopic Movement in Capsule of, 301
Leavitt, R. G., 239
Literature, Early Botanical, 25
Lloyd, Francis E., 223
Magnolia, An Indian, in America, 211
Mansfield, C. M., 17
Metcalf's Organic Evolution, [Review of], 86
Mimicry in Plants, 132
Mistletoe, Some Recent Observations on its Habits and Structure, 265
Monsoon Dust of the South Atlantic Ocean, 124
Mosses, Trees and Points of the Compass, 84
Moulds as the Cause of Disease, 128
Movement of the Branches in Shrubs and Trees, 83
Nash, George V., 63, 91
Nature Study of Maryland Plants, 309
Nehrling, H., 211
Oak, A Curious White, 17; The Cowthorpe, 208
Osterhout's Experiments with Plants, [Review of], 188
Overton and Hill's Nature-Study, [Review of], 110
Pammel, L. H., 31
Peterson's How to Know Wild Fruits, [Review of], 213
Photosynthesis, Experiment in, 263, 306
Phycophaein, 305
Pinchot's Primer of Forestry, [Review of], 214
Plants, How New Come in, 283
Pollen, The Great Abundance of, 186
Potato, Tubers, Are, Caused by a Fungus? 232
Ramaley, Francis, 139
Reed, Howard S., 163, 198
Regeneration, Notes on, 131
Robison's Outlines of Field Studies of Some Common Plants, [Review of], 264
Root-cage, A Cheap and Simple, 262, another, 305
Russian Secondary Schools, Biology and Physical Science in, 20
Salts, Relation of, to Natural Vegetation, 44
Sargent's Trees of North America, 213
Schneck, Jacob, 35
Seeds, The Vitality of, 260
Shaw, Charles H., 105
Smith's Bacteria in Relation to Plant Diseases, [Review of], 307
Spillman, W. J., 150
Stipules in the Cultivated Rubber Plant, 85
Streeter, S. G., 76
Streptocarpus, Unifoliate Species of, 134; Water Absorption by Leaf of, 306
Symposium, Botanical, at McCall's Ferry, Pa., 49; Field, at Ohio Pyle, Pa., 134
Thonger's Book of Garden Design, [Review of], 214
Transpiration in Xerophytic Leaves, 108
Tree Planting, A Practical Rule for, 222
Trillium, Variations in, 257
Tropics, A Summer in the, 6, 29
Twigs, Biology of Buds and, in Winter, 78
Underwood, L. M., 25
Water Absorption by Leaf of Streptocarpus, 306
Water Plant, A Tropical, 37
Watterson, Ada, 12
Wiegand, K. M., 78
Wiegand and Foxworthy's Key to the Genera of Woody Plants in Winter, [Review of], 213
Wild Flower Preservation Society of America, Minutes of the Philadelphia Meeting, 14; Report of the President, 39; Announcements, 79, 154, 285
Wild Flowers, A Treasure Spot of, 76; Early, 104; A Plea for the, 155
Zonal Distribution of South Atlantic and Antarctic Vegetation, 107

3 2044 103 101 382